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Soil Resources of the LARDEAU MAP AREA

(82K)

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British Columbia Soil Survey

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PREFACE

This report, Soil Resources of the Lardeau Map Area (82K), and the accompanying soil maps are the product of the soil survey of the Lardeau map area. Together they provide basic information about the classification, distribution and properties of the soils and their suitability and/or limitations for specified uses.

Fieldwork for this survey was carried out during 1971-1974.

The main body of the report consists of four chapters. Chapter One deals with the overall environment of the Lardeau area. Chapter Two describes the methodology used during mapping. Chapter Three consists of descriptions of soil associations of the area. Chapter Four contains a variety of soil interpretations for agriculture, forestry, engineering, hydrology, recreation and wildlife. A glossary, list of references and a number of appendices follow Chapter Four.

The information contained in this report is useful to resource managers primarily at generalized planning levels although some site specific detail may also be extracted. It also contains a climatic overview useful in determining the general suitability (or limitations) of tracts of land for a variety of uses.

The areal distribution of soil associations, landforms and slope classes of the Study Area are shown on the accompanying reconnaissance soil maps (scale 1:100 000). Delineated soil areas are identified by either one or a number of symbols; areas with the same symbol(s) contain the same kinds of soil.

The cover photograph was provided by D.R. Benn and the satellite photo (Plate 1) was supplied by National Air Photo Library, Ottawa, Ontario. Grateful acknowledgement is made to the Land Resources Research Institute, Agriculture Canada, Ottawa, Ontario for producing and publishing the soil maps.

Special recognition goes to the Editorial Committee, chaired by W.C. Yeomans and composed of the following members: Dr. T.E. Baker, L.J. Houston, H.A. Luttmerding, Dr. J.A. Shields, P.N. Sprout, and T. Vold who contributed their time for providing advice, guidance and critical comments concerning the technical editing for this report.

Drafting and graphics provided by the Cartography Section, Victoria and the Drafting Section, Kelowna, Resource Analysis Branch.

Plate 1: Satellite photo showing the Lardeau map area

chapter one

A GENERAL DESCRIPTION OF THE LARDEAU MAP AREA

365.5

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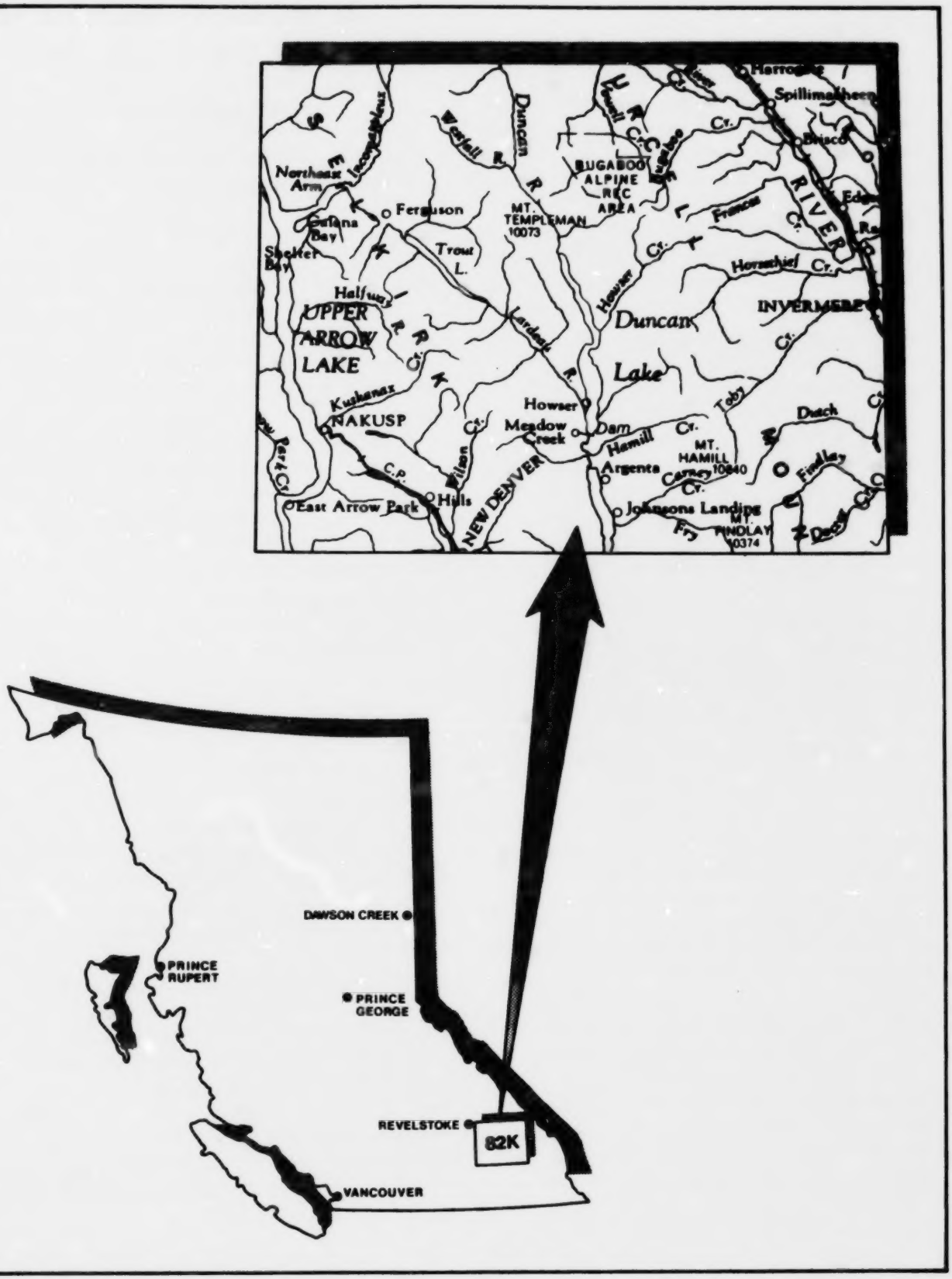


Figure 1: Location of Lardeau map area in relation to rest of British Columbia

1 A GENERAL DESCRIPTION OF THE LARDEAU MAP AREA

1.1 LOCATION AND POPULATION

The Lardeau map area (National Topographic Series map sheet 82K) is located in southeastern British Columbia between 50° and 51° north latitude and 116° and 118° west longitude. The map area extends about 70 miles from north to south and 85 miles from east to west, covering a total area of about 6100 square miles or 3.9 million acres.

The western boundary is in the vicinity of the Upper Arrow Lake basin and the eastern boundary is near the Rocky Mountain Trench. The villages of Nakusp and Invermere are the largest communities. Smaller centres of population are at Hills, Lardeau, Trout Lake, Meadow Creek, Edgewater, Radium, Spillimacheen and Brisco.

The total population of the map area is about 3500 (Department of Municipal Affairs, Province of British Columbia, 1972). Except for the area near Nakusp and Invermere, the map area is largely uninhabited.

1.2 HISTORY

After completion of the main line of the Canadian Pacific Railway as well as other modes of transportation, which created access to placer and hardrock mining sites, railway men and others turned towards prospecting and logging. During the two decades following 1885, various mining activities began in the Beaton and Camborne, Ferguson, New Denver, Sandon, Zincton and Retallack areas. The mining industry played a very important role in the initial development of the area and induced many people to settle there. Places of historical interest are located at Comaplix, Lardeau City, Circle City, Poplar Creek, Three Forks and Whitewater. Most of these settlements were situated near Trout Lake and between Kootenay Lake and Upper Arrow Lake, but little evidence of civilization remains there now.

Except for Sandon and Camborne, where mining operations continued through the 1950's, most mining booms lasted for only a few years. The economy of the area gradually changed from mineral-based to one based on forestry and agriculture.

Numerous mines, such as the one near Zincton shown below, and ghost towns, such as the one at Sandon, (Plate 3), lie forgotten. They reflect an era when "Silver was King".

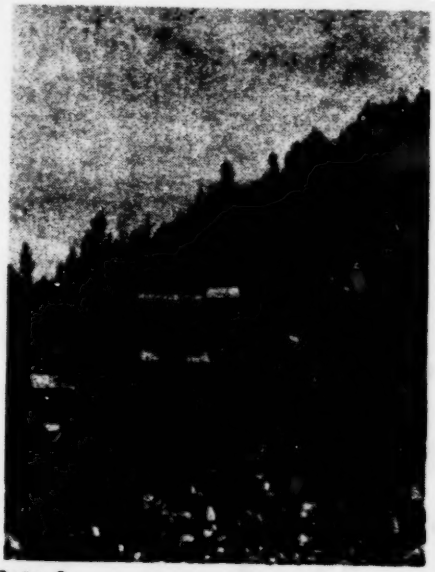


Plate 2

The trails and roads which formerly connected these places are now either gravelled or paved highways. Grades of the former Arrowhead and Kootenay railway, as well as parts of the Kaslo-Sandon and New Denver railways now serve as excellent secondary roads into the heart of the Lardeau map area. The C.P.R. paddle-wheel steamers on Arrow, Kootenay and Trout lakes have all disappeared; all-weather highways No.'s 6, 23 and 31 now connect Revelstoke and Nelson.

Radium Hot Springs is a major recreational feature of Kootenay National Park. These springs were used by the Indians for many years, but after the Canadian Pacific Railway was built from Golden

to Cranbrook and facilities were expanded in the early fifties, the Hot Springs gained national renown.

Plate 3

Highway 95 connects Golden with Cranbrook by way of the Rocky Mountain Trench. Numerous access roads penetrate the Purcell Mountains, but none cross the divide to the Duncan River drainage.

There are airfields suitable for small planes at Nakusp and Invermere. These two centres have the only medical and secondary educational facilities in the area. A hydro storage dam near Castlegar impounds the Arrow Lake - Columbia River system, and a second one at Duncan Lake impounds the Duncan River.

1.3 PHYSIOGRAPHY AND DRAINAGE

Most of the map area is occupied by the Columbia Mountain system - the Purcell and Selkirk Mountains - of the Interior system (Holland, 1964). A small portion in the northeast is occupied by the Rocky Mountain system. The mountain systems are separated by the Rocky Mountain Trench, a topographic depression extending northwestward almost throughout the length of British Columbia. In the map area this valley is occupied by the northward flowing Columbia River. Another notable physiographic feature is the Purcell Trench which separates the Selkirk and Purcell Mountains. It parallels the Rocky Mountain Trench and is occupied by the Duncan River, Duncan Lake and Kootenay Lake. The area to the east of the Purcell Mountains is commonly referred to as the "East Kootenay" while that on the west, and including the Selkirk Mountains, is known as the "West Kootenay".

Extreme relief characterizes the Columbia and Rocky Mountains. Mountain peaks in the Purcell and Selkirk Mountains rise to about 10,500 feet above sea level. The elevations of the main valleys range between 1460 feet at Upper Arrow Lake and 2630 feet at Windermere Lake. The main drainage, as illustrated in Figure 2, flows south through the Arrow Lakes and by the Kootenay,Columbia, Lardeau and Duncan rivers. In the Rocky Mountain Trench the Columbia River flows northward.

Plate 4: The Rocky Mountain Trench, a structurally controlled erosional feature, occupied by the Columbia and Kootenay Rivers. View looking southeast from Jubilee Mountain.

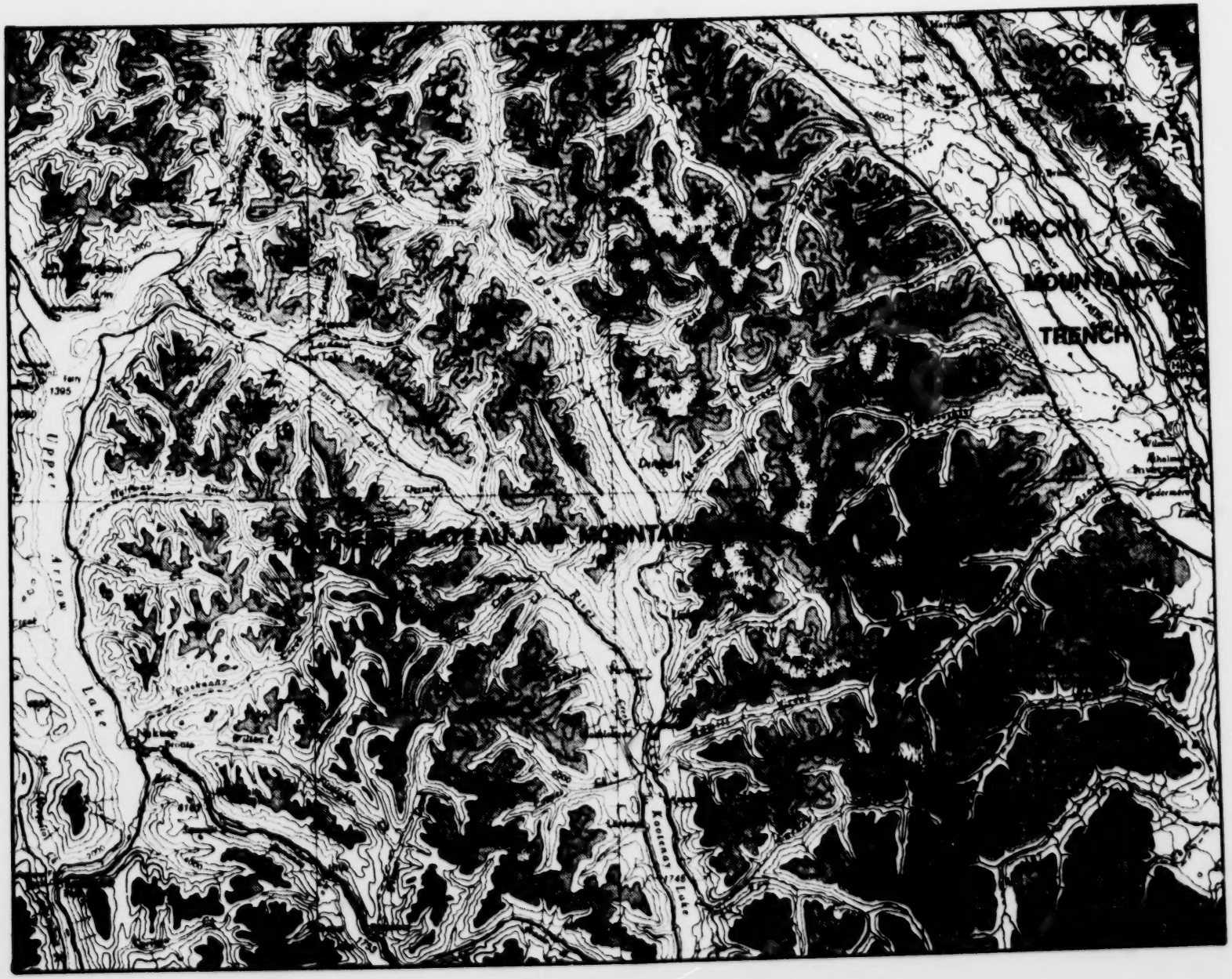


Figure 2: Physiographic subdivisions of the Lardeau map area

Plate 5: The serenity of the Upper Arrow Lake reflects in its' waters the densely forested slopes of the Selkirk Mountains. Plate 6: The Arrow Lakes serve as a great settling basin for the swiftly flowing Columbia River.

1.4 BEDROCK GEOLOGY

The Selkirk Mountains are composed of a variety of bedrock types (see Figure 3). Predominant are Proterozoic and Paleozoic sedimentary and metamorphic rocks, gneiss of igneous origin, late Palaezoic and Mesozoic sedimentary and volcanic rocks, and granitic stocks and batholiths of Cretaceous and Tertiary ages. The Kuskanax batholith occupies most of the area between Nakusp, Galena Bay and southwest of Trout Lake to Nakusp. Triassic sedimentary rocks (Slocan group) occupy most of the southern area of the map sheet between Nakusp and Kootenay Lake (Holland, 1964; Reesor, 1973).

The Purcell Mountains consist primarily of sedimentary and metamorphic rocks of Proterozoic and Lower Paleozoic ages. Most of these rocks are quartzite, argillaceous quartzite, argillite and some limestone. Several Cretaceous intrusions composed mainly of quartz monzonite and granodiorite are commonly known as the Fry Creek, Bugaboo, Horsethief and White Creek batholiths (Reesor, 1973). The northwest-southeast trend of individual ranges within the Purcell Mountains is controlled by numerous faults.

The Brisco and Vermilion Ranges of the Rocky Mountains are located northeast of the Rocky Mountain Trench and are characterized by complex geologic structures. They consist primarily of Cambrian and Ordovician blue-grey limestone and argillaceous limestone, light-grey dolomite and dolomitic limestone (Holland, 1964).

Quartzite and limestone are strongly resistant to erosion and form most of the higher peaks of the Lardeau map area. Notable are Mts. Hamill, Kindersley and Findlay. Peaks composed of granite or granitic rock are massive, rounded and subdued. Sharp and pinnacled peaks, such as Mt. Brennan and Mt. Whitewater are composed of slates and shists.

The headwaters of Bremner, Kuskanax, Poplar, and St. Leon creeks and Halfway River show the rectangular drainage pattern typical of granite and related intrusive rocks.

Most of the mountain ranges have long, uniformly steep and heavily timbered slopes. All valleys are deeply entrenched and many of their creeks are still fed by glacial meltwater.

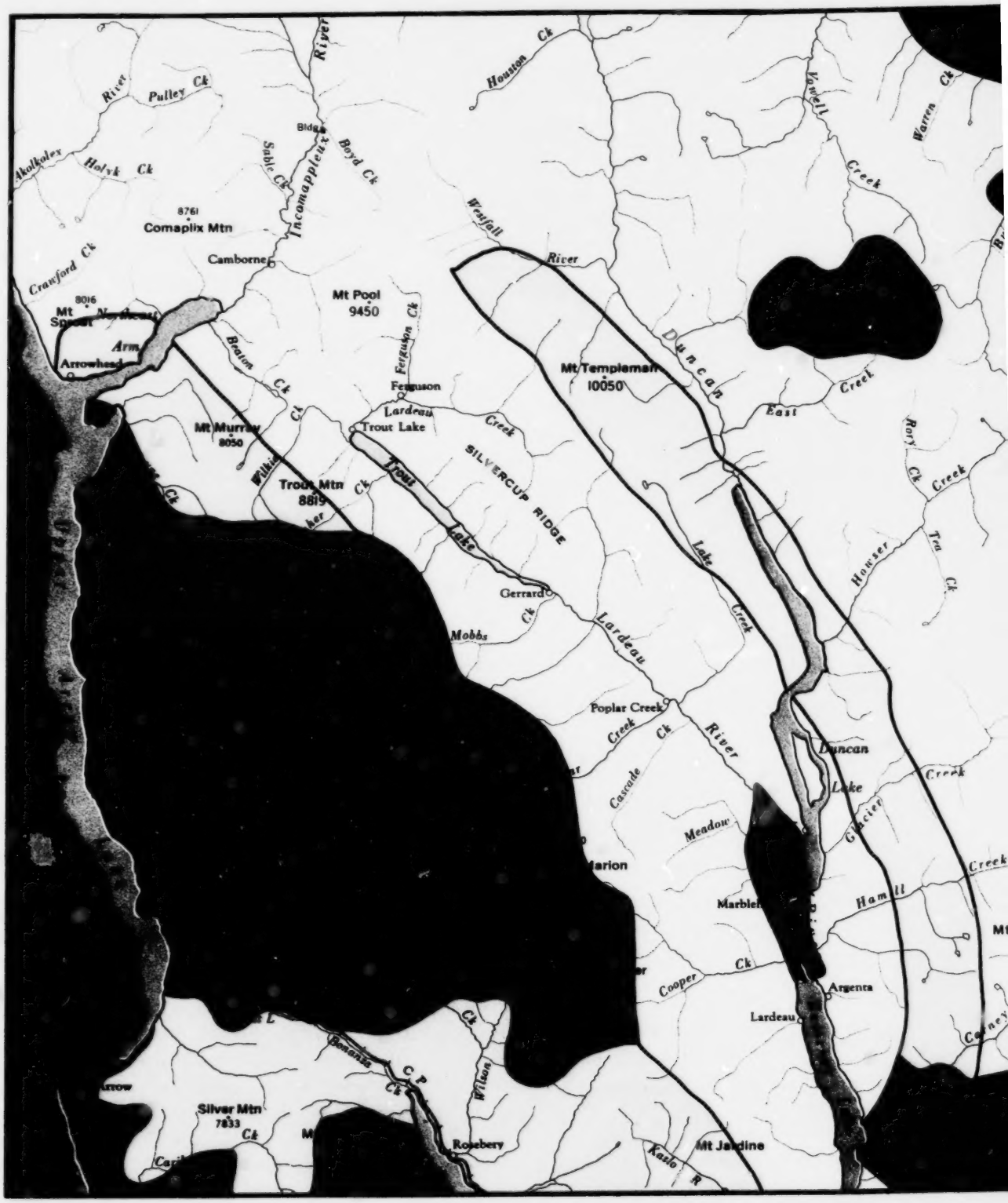
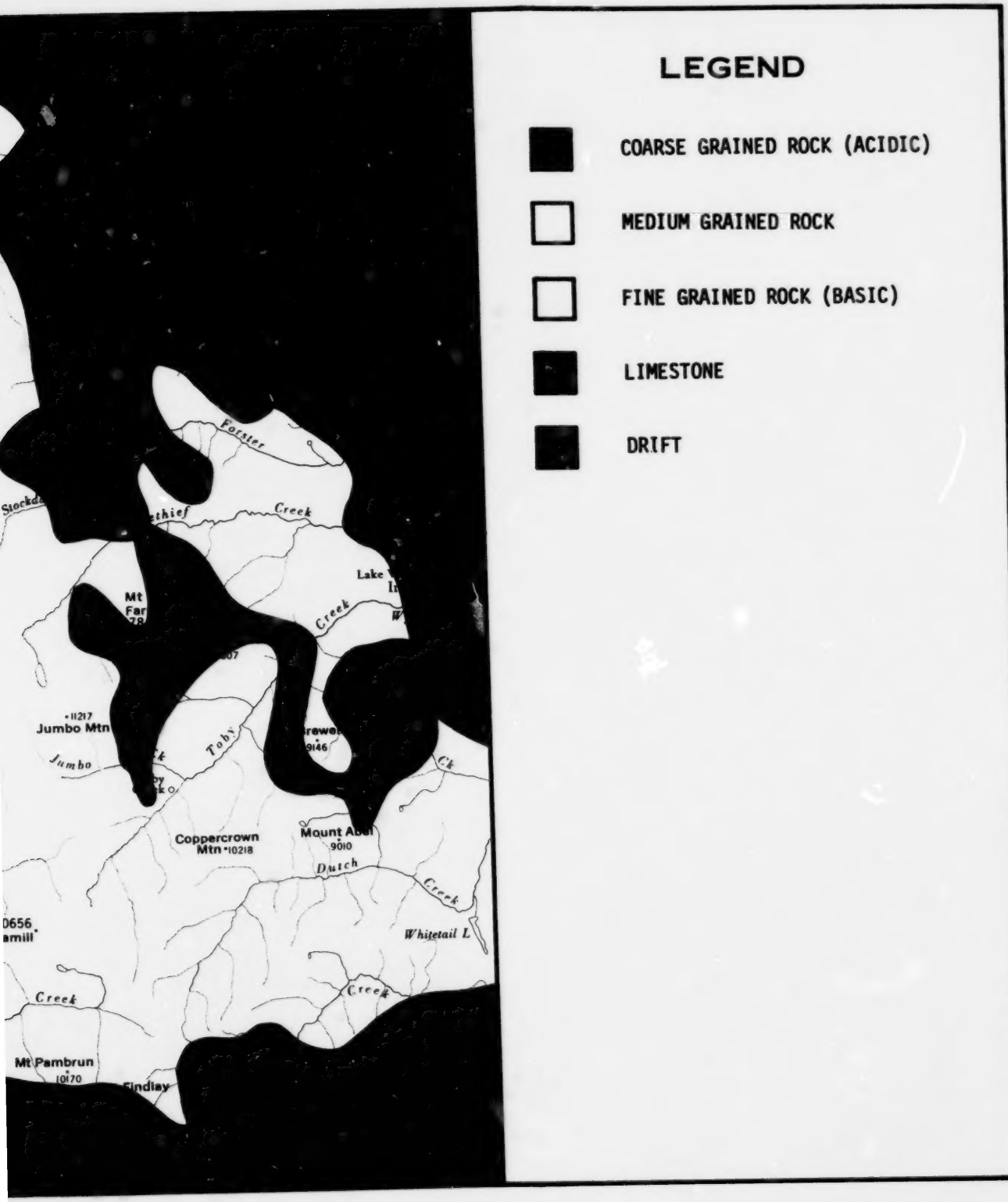


Figure 3: Generalized bedrock geology of the Lardeau map area


LEGEND
COARSE GRAINED ROCK (ACIDIC)
MEDIUM GRAINED ROCK
FINE GRAINED ROCK (BASIC)
LIMESTONE
DRIFT
Forster
Creek
Lake
Creek
Jumbo Mtn
Jumbo
Toby
Coppercrown
Mtn
Mount Abel
9010
Dutch
Creek
Whitetail L
Creek
Creek
Mt Pambrun
10170
Findlay

Many years ago nature's forces were active in mountain uplift and deformation of bedrock. Plate 7 is an example of a folded slate near Retallack (east of New Denver).

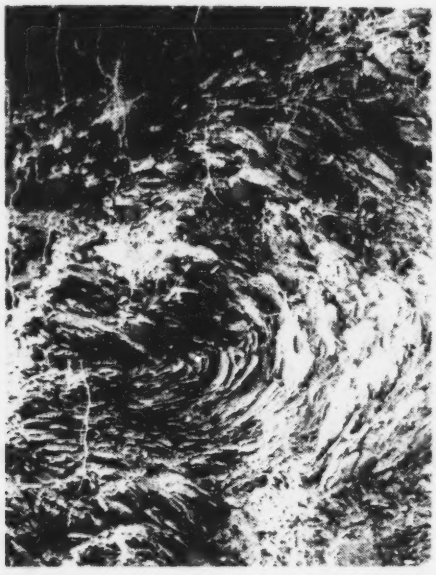


Plate 7

During the last glaciation, major ice-streams flowed southwards along the Rocky Mountain Trench and the Duncan and Arrow Lakes valleys. These were fed by systems of tributary glaciers that flowed from accumulation zones on the higher parts of the local mountains. The ice-surface elevation was about 7000 feet over the main valleys, and rose to 9000 or 10,000 feet in the snow accumulation zones (Ryder, 1977).

Most valleys within the map area are typical glacial troughs. At higher elevations, features of alpine glaciation - cirques, horns, aretes - form a spectacular mountain landscape. Cirque glaciers and summit icefields remain in many areas of the Purcell and Selkirk Mountains and at present, occupy about 70,000 acres in the Lardeau map area.

1.5 SURFICIAL GEOLOGIC DEPOSITS (SOIL PARENT MATERIALS)

Surficial geologic deposits (Soil Parent Materials) in the Lardeau map area were deposited by glaciers, water, wind, or derived from bedrock by weathering and mass wastage.

1.51 ICE-TRANSPORTED (MORAINAL) DEPOSITS

These materials were deposited directly by glaciers without modification by any intermediate agent. They include typical glacial till and the rubbly deposits associated with cirque glaciers. Typical glacial till is compact, non-stratified and contains a heterogenous mixture of particle sizes in a matrix of sand, silt and clay (Plate 8).

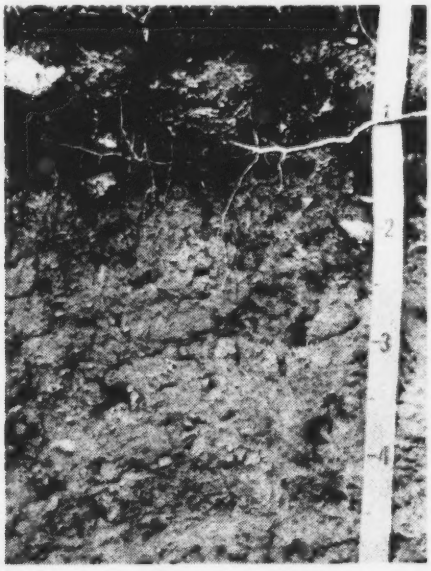


Plate 8

The composition of glacial till is generally related to the bedrock over which the glaciers passed. Till north of Nakusp and east of Kootenay Lake has sandy loam or loamy sand texture. It was derived mainly from granitic and quartzitic bedrock. Medium and fine textured till is found primarily in the southwest of the map area where slate, argillite and phyllite are the main rocks. Calcareous till is present in the northeast of the map area and is associated with the dominant limestone and dolomitic bedrock.

Figure 4: Surficial deposits of the Lardeau map area

Most glacial till deposits, at the lower elevations, are present as blankets, usually thicker than five feet, over the subdued and hummocky bedrock. Glacial till within the Rocky Mountain Trench, north from Invermere, is typically drumlinized. The following soil associations* have developed from glacial till deposits: Slocan, Stobart, Sentinel, Stubbs, Steenhoff, Sandner, St. Leon, Swehaw, Sandon, Spillimacheen, Wycliffe and Kinbasket.

1.52 GRAVITY-TRANSPORTED (COLLUVIAL) DEPOSITS

The colluvial deposits are the dominant soil parent materials in the Lardeau map area. They are a product of mass wasting and have reached their present position by direct gravity-induced movement. Generally they are found at higher elevations on steep and very steep topography.

In the Lardeau map area, the colluvial deposits were divided into those which were deeper (blankets) or shallower (veneer) than five feet overlying bedrock. Colluvial blankets modify the irregularities in the underlying surfaces, but reflect their dominant topography. The texture depends on the nature of the material from which it is derived. If bedrock is the source, the colluvium will probably be stony and coarse textured, although the degree and rapidity of weathering of the mineral constituents sometimes produces colluvium of finer texture. Where the colluvium is derived from other surficial deposits, its texture is similar to the original deposits. The following soil associations have developed on colluvial blankets: Cooper, Comaplix, Curtis, Mount Cond, Calamity, Cataract, Coppercrown, Carney, Clifty, Champion, Cervil, Coubrey, Conrad and Couldron.

Colluvial veneers are less than five feet thick over bedrock. They generally are too thin to mask minor topographic irregularities in the underlying bedrock surface but otherwise are similar in characteristics to colluvial blankets.

A colluvial veneer overlying highly fractured, easily weathered bedrock is shown in Plate 9. Plate 10 depicts an example of a shallow colluvial veneer overlying granitic bedrock.

Plate 9

Plate 10

* For discussion of soil associations, see chapter three.

The following soil associations have developed primarily from colluvial veneers, although minor inclusions of deeper colluvial deposits may also be present: Buhl Creek, Bergman, Bohan Creek, Blaylock, Blizzard, Burkitt, Bluejoint, Beaton Creek, Brouse, Beatrice, Bonner, Burn Creek, Big Fish, Brennan, Bunyon, Badshot, Rossland and Radium.

Talus, also a type of colluvium, is defined as angular rock fragments produced by frost action from exposed bedrock slopes and scarps. It is rubbly and bouldery in nature and separate soil associations, Yahk Creek and Ymir, have been mapped on these deposits.

1.53 WATER-TRANSPORTED (FLUVIAL AND GLACIO-FLUVIAL) DEPOSITS

Recent fluvial (alluvial) materials, deposited by present day rivers and streams, have fine sandy and silty textures in their surfaces and are generally underlain by gravelly sand or gravelly loamy sand. Large areas of these dominantly medium to coarse textured deposits are found in the Incomappleux River valley, near the north end of Kootenay Lake, in the lower Duncan River valley and on the floodplain of the Columbia River between Invermere and Harrogate. Some smaller areas occur in the Lardeau River valley. Avis and Nowitka soil associations have developed from these deposits.

Fluvial fans are located along the margins of valley floors where gradients of steep side streams change. On entering, the gradients are reduced abruptly and much of the load is deposited. Texturally, fans consist of variable mixtures of gravel, sand and finer particles containing various contents of stones and cobbles. Usually the textures are coarsest at the apex of the fans and become finer toward the apron. The surfaces are marked by abandoned and active stream channels.

Many fluvial fans occur in the Rocky Mountain Trench north of Invermere as almost all creeks that drain into the Columbia River have developed fans. Fry, Davis and Schroeder creeks form fans at the point of entering Kootenay Lake. Others are at Wilson Creek, where it flows into Slocan Lake, and on a number of small creeks along the perimeter of Trout Lake. Fairmont and Fruitvale soil associations have developed from fluvial fan soil parent materials.

Glaciofluvial deposits were laid down during or immediately subsequent to glaciation. They occur as a variety of ice contact deposits, kames and terraces generally composed of gravel and/or sand. Their textures range from gravelly loamy sand to sand throughout the soil profile. Kame deposits often occur in conjunction with colluvium and glacial till.

Glaciofluvial deposits are widespread over the map area. The majority, however, occur as well to poorly sorted deposits along the major valleys, such as those along Upper Arrow Lake, Kootenay Lake and the upper Columbia River. In many smaller side valleys these deposits occur sporadically on the steep slopes high above present creeks (i.e. Kuskanax Creek and Halfway River). Level and hummocky fluvial terraces are present throughout the map area at valley bottom elevations. Calcareous gravelly and sandy terraces are associated with the drumlinized morainal deposits in the Rocky Mountain Trench and occupy former meltwater channels. Soil associations that have formed from glaciofluvial deposits are Kaslo, Kuskanax, Kingcome, Keeney and Gillis.

1.54 FRESH-WATER DEPOSITED (LACUSTRINE AND GLACIOLACUSTRINE) SEDIMENTS

Lacustrine (and glaciolacustrine) deposits consist of sediments which have settled in lakes. These sediments have particles ranging in size from silt and very fine sand to clay and typical soil textures range from silt loam to clay loam.

The largest lacustrine deposits occur in the northeast of the map area where they flank the

Columbia River. They are typically 100 feet or more deep and are calcareous throughout. A small area of lacustrine sediments also occurs in the Vowell Creek valley. The sediments here are comparatively shallow, moderately coarse textured generally do not exceed 10 feet in thickness, and may have been deposited in a temporary ice-dammed lake. Other lacustrine deposits occur near the southern end of Upper Arrow Lake and in the Arrow Park Creek area. Post-glacial erosion and piping has formed gullies which have receded about one-half mile from the escarpment edge in all lacustrine sediments and are well expressed in the deposits north of Invermere. Soil associations which have developed from lacustrine sediments, are Mayook, Linten and Lawley.

1.55 WIND-TRANSPORTED (EOLIAN) DEPOSITS

Since the general retreat of the glaciers and the drying of the landscape about 10 to 20 thousand years ago, and before vegetation became generally established, a large area of the Rocky Mountain Trench was exposed to severe wind erosion. These pro-glacial winds deposited silt and very fine sand over a large portion of the landscape. The thickness of these eolian deposits ranges from a thin, scarcely observable layer to a mantle of a foot or more (Kelly, 1961). Soil associations mapped in the Rocky Mountain Trench have variable depths of fine sandy or silty eolian cappings over the underlying morainal, glaciofluvial or lacustrine deposits.

Another type of wind-transported deposit in the map area is volcanic ash. These deposits are present over most of southern British Columbia and occur in various amounts in the uppermost horizons of many soils of the Lardeau map area. The volcanic ash occurs as a thin white layer(s) or has been incorporated with the other materials. Volcanic ash layers are best expressed in wet, depressional, organic areas. Here the ash occurs as layers generally ranging from 1/4 inch to about two inches in thickness.

Volcanic ashes are composed of non-crystalline glass shards, weatherable feldspars and ferromagnesium minerals. Small amounts of quartz may also be present. Volcanic ash from several sources have been identified in British Columbia, including those known as: Mazama, Glacier Peak, Bridge River, St. Helens Y and W. No attempt has been made to identify or separate the various ashes found in the map area, but Mazama and St. Helens are the most likely sources.

Plate 11 indicates a thin band of volcanic ash buried in colluvium while Plate 12 shows a soil surface consisting of an Ae horizon mixed with volcanic ash.

Plate 11

Table 1 contains several analyses of a variety of "ashy" horizons found in the Lardeau map area. The accompanying map, Figure 5 shows the sampling locations. Bulk density determinations were done by the Volumeasure method (Soil Test. ASTM) and Soil Clod method (Brasher, et al., 1966).

Table 1: Analysis of volcanic ash horizons for bulk density

PARENT MATERIAL	DEPTH	MAP LOCATION	HORIZON	OXALATE		PYRO PHOSPH.		BULK DENSITY	
				Fe	Al	Fe	Al	Volume	Clod Saran Method
Almost pure volcanic ash layer (Shannon Creek)	24"	1	ash	1.59	2.90	0.35	1.33	0.89	0.87
		1							0.53
		1							0.66
		1							0.66
		1							0.75
Outwash (gr.), kame (obvious volcanic ash)	0-4"	2	Bm1	0.93	1.22	0.15	0.33	0.87	
	4-8"	2	Bm2	1.03	1.50	0.13	0.42	0.81	
	4-8"	2	Bm2	0.79	1.00	0.10	0.28	0.68	
Outwash (gr.), kame (no obvious ash)	1-4"	3	Bm	0.38	0.76	0.03	0.19	1.14	
	1-4"	3	Bm	0.37	0.73	0.04	0.15	1.29	
Outwash (sands) at (Kuskanax Ferry)	0-5"	4	Bm	0.48	1.46	0.02	0.16	0.83	
	0-5"	4	Bm					0.78	
Outwash (gr.), kame (Shelter Bay)	0-3"	5	Ae or ash	0.10	0.13	0.01	0.08	1.26	1.49
	3-6"	5	Bm	0.97	2.65	0.15	0.77	0.95	
Outwash (MacDonald Creek)	0-4"	6	Ae and ash					0.66	0.60
	0-4"	6	Ae and ash						0.60
	0-4"	6	Ae and ash						0.41
	4-8"	6	Bf						0.73
	4-8"	6	Bf						0.54
Outwash sand (Nakusp Hot Springs)		7		0.17	0.17	Trace	0.08	1.23	
Coarse till (Blueberry-Paulson)	0-5"	8	Bf	1.16	2.38	0.02	0.33	0.75	0.90
	0-5"	8	Bf					0.72	0.87
	0-5"	8	Bf	1.18	2.28	0.05	0.42	0.73	0.91
Colluvium over Rock (Salmo-Creston Summit)		9	Bf	1.20	1.03	0.74	0.75	0.55	0.72
		9	Bf	1.26	1.17	0.62	0.75	0.72	0.87
		9	Bf	1.34	0.95	0.71	0.65	0.73	
Colluvium over till		10	Bm	1.11	1.31	0.18	0.45	0.52	
		10	Bm	1.35	1.34	0.19	0.57	0.68	
Outwash sands (no obvious ash) Castlegar Airport	0-4"	11	Bm	0.32	0.79	0.04	0.26	1.28	
	0-4"	11	Bm	0.49	0.97	0.03	0.19	1.27	
Outwash sand (no obvious ash) Castlegar Airport	0-5"	12	Ah	0.36	0.78	0.04	0.24	1.11	
	0-5"	12	Ah	0.32	0.81	0.23	0.23	1.14	
Outwash and kames (W of Passmore at Little Slocan Lake)	0-4"	13	Bf	0.36	0.63	0.08	0.23	1.33	
	0-4"	13	Bf	0.40	0.68	0.08	0.21	1.35	
	0-4"	13	Bf	0.37	0.61	0.10	0.25	1.58	
Basal till (obvious ash layer above B horizon) (Little Slocan Lake)	0-4"	14	ash	0.48	1.05	0.17	0.60	0.82	
	0-4"	14	ash	0.48	1.05	0.13	0.52	0.84	
Basal till (obvious ash layer above B horizon) (Little Slocan Lake)	0-4"	15	ash	1.58	1.69	0.63	0.80	0.66	
				1.51	1.55	0.51	0.72	0.67	
Ash layer in Organic Bog	16-18"	16	ash				0.71		

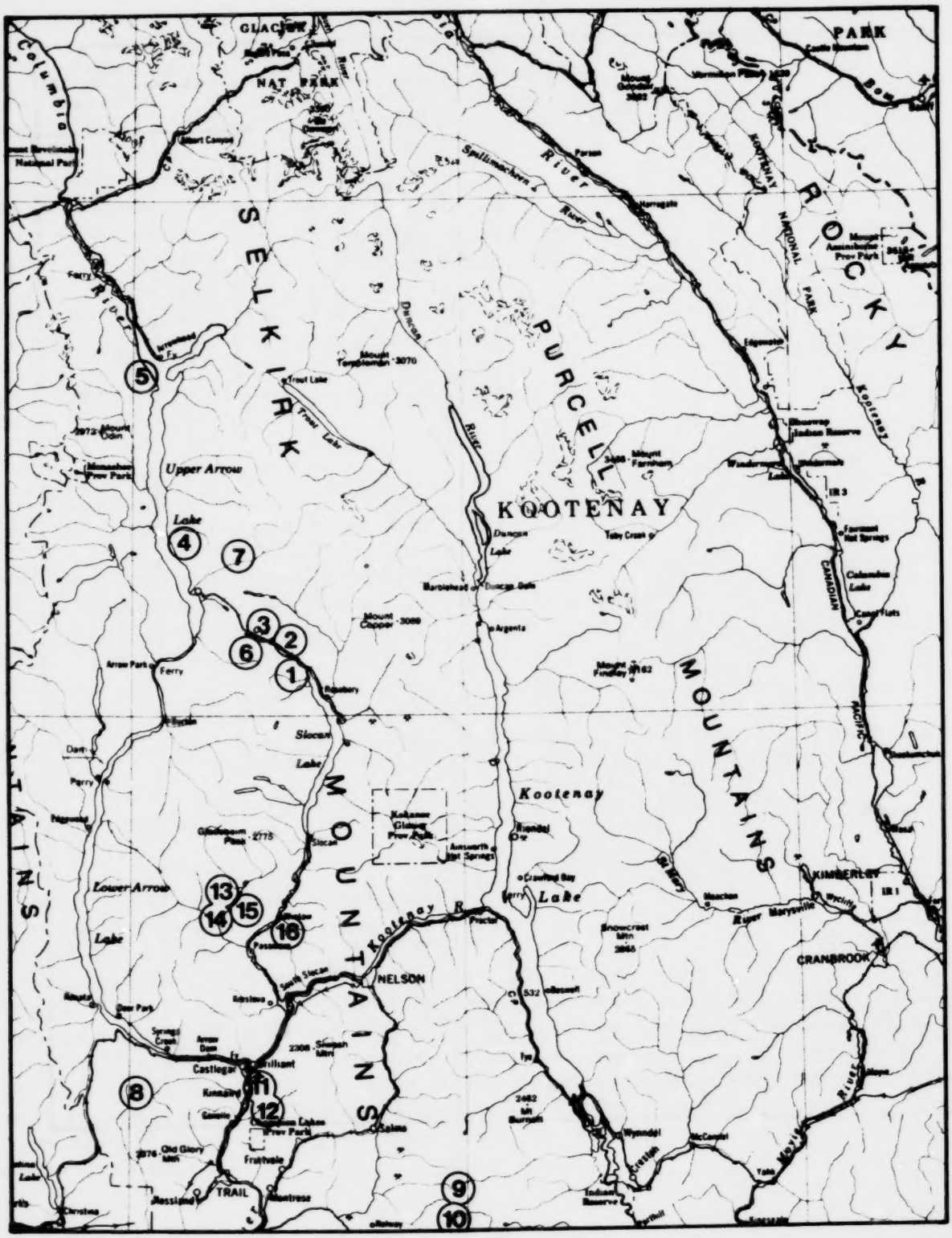

SELKIRK MOUNTAINS
PURCELL MOUNTAINS
ROCKY MOUNTAINS
KOOTENAY
Upper Arrow Lake
Lower Arrow Lake
Slocan Lake
Kootenay Lake
Columbia River
Kootenay River
Duncan River
Trout Lake
Mount Tupper 3070
Mount Copper 3099
Mount Findlay 3162
Mount Farnham
Mount Cheops 2972
Mount Odin
Mount Abbott 2872
Mount Sir Donald 3284
Mount Assiniboine 3618
Mount Ostman 3652
Mount Brownface 3555
Mount Fisher 3255
Mount Joffre 3450
Mount Ball 3311
Mount Temple 3544
Mount Hungabee 3492
Mount Deltaform 3424
Mount Goodsir 3562
Mount Bryce 3507
Mount Columbia 3747
Mount Forbes 3612
Mount Lyell 3535
Mount Alexandra 3519
Mount Saskatchewan 3342
Mount Wilcox 3116
Mount Wilson 3260
Mount Murchison 3333
Mount Stutfield 3450
Mount Athabasca 3491
Mount Kitchener 3490
Mount Columbia 3747
Mount Bryce 3507

Plate 12

Plate 13

1.6 MODIFYING PROCESSES ACTING ON SOIL PARENT MATERIALS

1.61 "SOIL STABILITY" IN STEEP MOUNTAINOUS TOPOGRAPHY

Whenever a mass of soil exists on a surface that is not horizontal, internal shear stresses develop which tend to move the upper portions downslope. When the internal shear stresses exceed the shearing resistance of the material, downslope movement will occur. If the area of movement is large, massive slope failures result. Such failures are usually deep-seated rather than surface phenomena. They generally occur quite suddenly and are commonly known as landslides. In addition to landslides, surface phenomena such as erosion, scour, mud flows, and creep are included in the consideration of the stability of slopes.

Soil creep is slow downslope movement of soil and rock under the influence of gravity and is often facilitated by saturation with water. Creep also includes a gradually increasing deformation of soil materials. Soil creep of low magnitude has been observed in almost all steeply sloping soils in the map area. Its presence is often indicated by slight curvatures of tree trunks ("pistol butt"), (Plate 13) and can also be seen in the thickness of the soil overhang on the upper side of old excavations. Soil creep is most evident on medium or finer textured colluvial or morainal deposits on steep slopes. The soil horizons are often mixed or displaced.

1.62 SOLIFLUCTION AND OTHER PERIGLACIAL MASS-MOVEMENT IN AN ALPINE ENVIRONMENT

Solifluction is termed as "surface modification by the process of slow gravitational downslope movement of saturated non-frozen earth material..." (E.L.U.C. Secretariat. 1976). Solifluction is thus a downslope flow of water-saturated material with gravity as the motive force. The cool, moist alpine climate creates the saturated soil conditions required for instability.

A few areas of alpine soils in the study area, such as Rossland and Radium associations, exhibit this phenomenon. These areas are generally only sparsely vegetated and the small amount of turf and moss may, under certain conditions, retard the semi-fluid layer. Slower and more imperceptible flow movements form lobes in less hilly topography. These soils generally show a churning or mixing of soil horizons.

1.7 CLIMATE

The Selkirk and Purcell Mountains have a pronounced influence on the climate in the Lardeau map area. The rugged topography ranges in elevation from 1400 feet in the southwest near the the Columbia River to peaks over 10,500 feet in the Purcell Mountains. The moist, eastward moving maritime air from the Pacific Ocean rises against the western slopes of these ranges, releasing most of its precipitation. In general, the precipitation increases northward and also increases rapidly with elevation. In the Arrow Lakes valley, the annual precipitation varies from 22.6 in/yr near Fauquier to 43.2 in/yr near Revelstoke.

The East Kootenay region is situated in the lee of the Purcell Mountains and has lower annual precipitation. The trend, however, toward increasingly moister conditions northward is also apparent here (Brisco 16.54 in./yr., Golden 18.60 in./yr.).

Throughout most of the lower elevations, 30 to 40% of the annual precipitation falls as snow. This percentage increases with elevation. For example, 65% of the 59 in. annual precipitation at Glacier (4094 feet elevation) falls as snow.

Mountain ranges and large lakes influence temperatures within the map area. Though temperatures usually decrease with increasing elevation, cold upslope air may be funnelled down narrow valleys (cold air chutes) to the main valley floor effectively reducing the frost-free period. Data on frost-free periods for some selected stations are shown in the Appendix Table 11. In contrast to the extremes created by cold air chutes, large lakes such as the Upper Arrow and Kootenay exert a moderating influence on the local climate. Detailed precipitation and temperature data for selected stations is presented in Appendix Table 10.

1.8 VEGETATION* (FOREST ZONATION)

The interaction of climate, topography, soil and time creates the environment in which plants compete for space, nutrients, moisture, and light. When given sufficient time without disturbance, the total vegetation will develop into stable combinations of plants which reflect the biological potential of the environment. These are called "climax" communities.

Disturbances such as fire, insect and disease damage, grazing, browsing, logging and land clearing temporarily eliminate the competition between plant species. "Seral" species, which tolerate the above conditions, become established. Subsequently, competition will result in the progressive replacement of species until a climax community, again in balance with its environment, is re-established. The process of progressive replacement of species is referred to as "succession". Typical examples of succession are: Fireweed-lodgepole pine to Engelmann spruce-alpine fir** or, in the interior, to western hemlock. A knowledge of the climax and the succession sequences and their relationship to the climate, soil and the landscape are required to understand the optimum resource-use options offered by the natural systems.

In British Columbia, the interaction of the westerly air flow and the mountainous topography result in vertical sequences of more or less horizontal belts of forests composed of the same potential climatic climax species and associated successional sequences. These forested belts

* Vegetation classification statements are adapted from Biophysical Seminar, 1975. Throughout this report, zone is used to mean Forest Zone (van Barneveld, 1976) and Douglas-fir is used to mean Rocky Mountain Douglas-fir (Taylor, 1977).

** Tree species in this report named after Taylor, 1977.

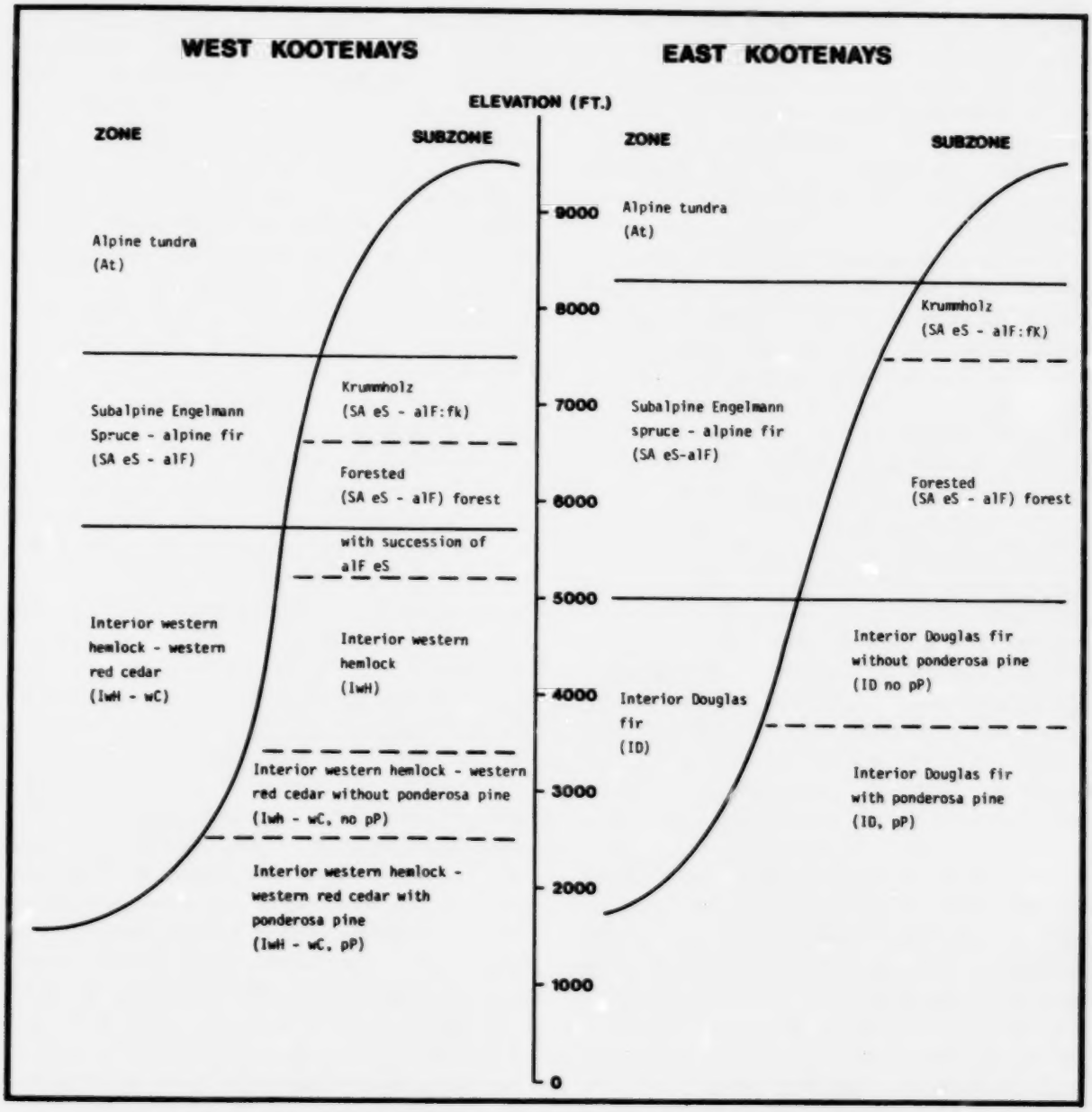


Figure 6: Sequence of forest zones and subzones in the East and West Kootenay region

provide the framework for the classification of forest zones and are defined on the basis of the potential distribution of climax tree species occurring on well-drained, deep, medium-textured soils on non-exposed sites (van Barneveld, 1976).

A forest zone may be subdivided into subzones according to differences in possible successional sequences. For example, the Interior Douglas-fir zone is subdivided into a lower Douglas-fir subzone with potential occurrences of seral ponderosa pine, and an upper Douglas-fir subzone in which by definition, ponderosa pine does not occur. Similarly, subzones are established on the basis of gross differences in growth form and type of forests. For example, the Subalpine Engelmann spruce-alpine fir zone is subdivided into a "forested subzone" and a "krummholz subzone". Within each zone, the climatic climax is formed by particular tree species or combination of species.

In each geographic area, the vertical sequence of zones and their altitudinal position is a reflection of the macroclimate. For example, the sequence of zones in the West Kootenays differs from that in the East Kootenays (see Figure 7). The climate between these areas differs considerably as well. Therefore, areas that have the same sequence of forest zones occurring between certain altitudinal limits, represent important delineations of natural (biophysical) systems.

Within each forest zone and subzone a variety of environmental conditions (biophysical sites) may occur due to localized variations in climate, soil or landscape position. A site is defined as an area with homogenous soil, atmospheric condition and vegetation characteristics. Disturbance history is responsible for a variety of vegetation types on sites which otherwise would be similar. Therefore, when such sites have a similar climax vegetation, they may be considered to reflect generally similar climatic conditions.

The framework of forest zone systems, forest zones and subzones and their implied climate characteristics is "built into" the soil maps. In this way, the soil maps apply to a wider range of land resource users and managers. They permit a better understanding of the natural biophysical systems. They also increase the predictability of the vegetative component of the system because of much improved correlation between soil and vegetation classifications. (See Figure 9).

The vegetation in the Lardeau map area can be differentiated vertically into three main forest zones* in both the East and West Kootenay macroclimatic areas. Together they result in the following four distinct forest zones in the whole study area:

a) Interior western hemlock-western red cedar forest zone in the West Kootenay region.
b) Subalpine Engelmann spruce-alpine fir forest zone common to both the East and West Kootenays.
c) Alpine tundra zone common to both the East and West Kootenays.
d) Interior Douglas-fir forest zone in the East Kootenays.

1.81 INTERIOR WESTERN HEMLOCK-WESTERN RED CEDAR FOREST ZONE

This zone is the most extensive in the western two-thirds of the Lardeau map area. It extends from the valley floors to an upper limit of 4500 to 5600 feet, depending on precipitation, latitude, air drainage, aspect and other environmental factors. Vegetation varies from almost pure stands of western hemlock on acid soils in well-drained, cool sites to a variable mixture of western hemlock and western red cedar on warmer sites that have medium textured or weakly acidic soils, or both. Within this zone, considerable areas are edaphically modified to render stands of different

* These are comparable to the Biogeoclimatic zones described by Krajina, 1965.

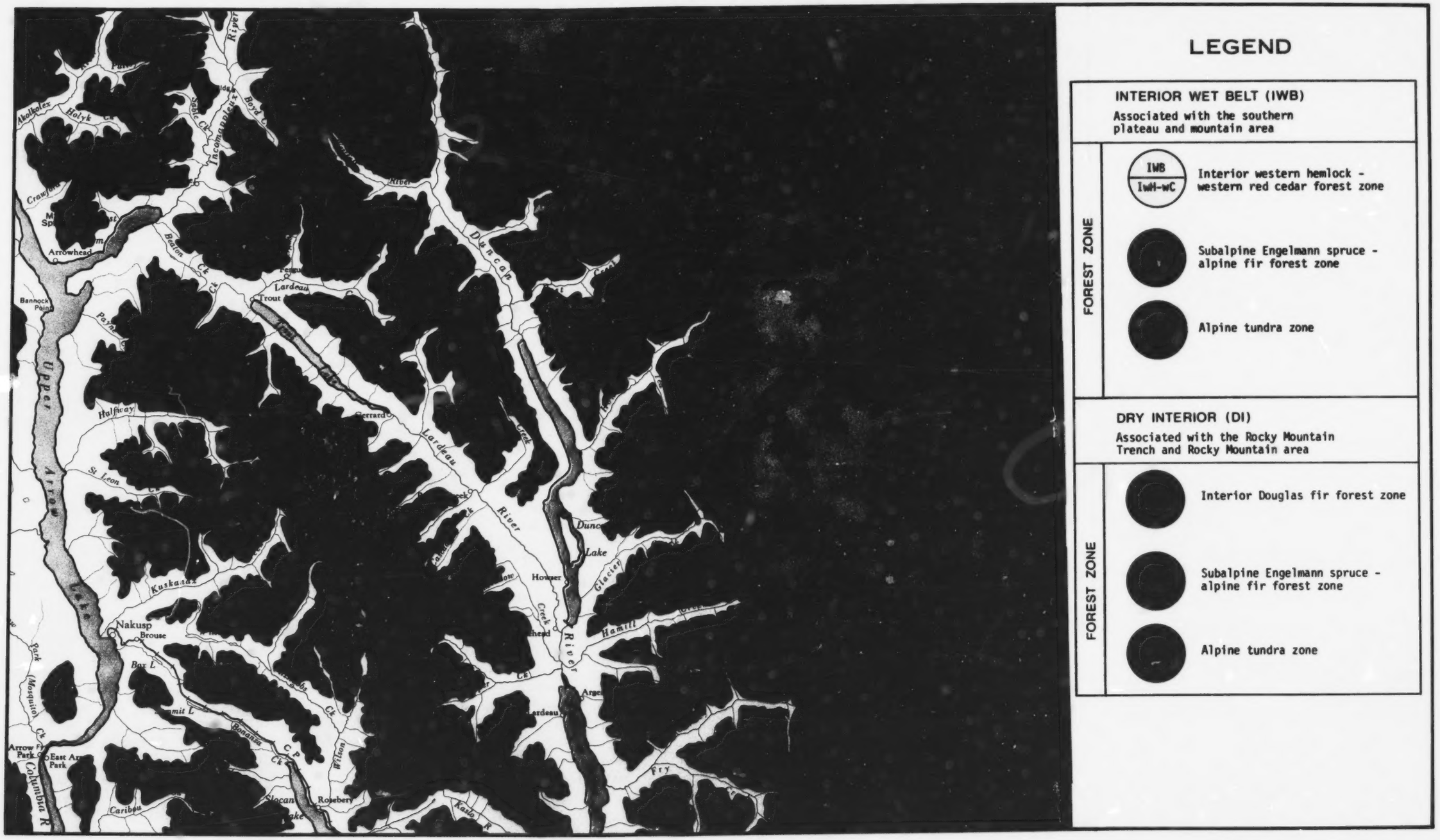


Figure 7: Forest zones of the Lardeau map area

climax potential and successional sequences of vegetation. Extensive areas of shallow soil overlying bedrock on southern exposures are edaphic climaxes of Douglas-fir.

Recent alluvial deposits in main valleys generally have high or fluctuating water tables. Black cottonwood, willows and, on sites not subject to frequent flooding and subsequent material deposition, western red cedar, are characteristic of the vegetation potential.

Some common seral species of the western hemlock-western red cedar zone are Douglas-fir, western white pine, western larch and paper birch.

Many coarse-textured, well to rapidly drained soils in the Arrow and Kootenay Lake valleys are influenced by high evapotranspiration and often produce seral stands of ponderosa pine, Douglas-fir, or a mixture of both.

Coarse-textured, acidic soils on cool sites frequently produce dense regeneration of climax western hemlock, as is the case in the granitic batholithic intrusion area northeast of Nakusp.

At the uppermost elevations of the Interior western hemlock-western red cedar zone, alpine fir and Engelmann spruce may be present as seral species. The climate of these areas gives the climax species, western hemlock, a marginal competitive advantage. However, removal of the protective tree canopy may temporarily alter the site climate sufficiently to favour establishment of alpine fir and Engelmann spruce. Western hemlock will not successfully establish on these sites until a new canopy of Engelmann spruce and alpine fir reduces the insolation to the original levels. At locations where deep snow cover prevents freezing of the soil, and where sufficient moisture is available during the growing season, hemlock sp. may be present up to timberline.

1.82 INTERIOR DOUGLAS-FIR FOREST ZONE

The Interior Douglas-fir zone occurs only in the East Kootenay part of the Study Area. It is the lowest elevation forest zone and is characterized by a climax of Douglas-fir. In this zone elevationally, white spruce forms edaphic climax stands on seepage sites, in depressions where moisture accumulates, on lower river terraces with high watertables and other relatively wet areas. River terraces subject to frequent flooding support stands dominated by black cottonwood or willows. Locally, on the lower slopes of the Rocky Mountain Trench and probably associated with seepage and northern exposure, western red cedar fringes some of the gullies.

On south and southeast-facing slopes of all valleys with shallow to bedrock soils, open-forest stands of Douglas-fir form the climax forest. In the extreme southeast corner of the map area, (lower valley of Findlay Creek), a treeless area characterized by alkali grass and salt grass reflects the calcareous (and sometimes saline) soil conditions.

The Interior Douglas-fir zone generally extends from the valley floors to above 4000 feet. However, in side valleys influenced by cold air draining from the higher elevations, the upper limit of this zone may not extend beyond 3500 feet. In contrast, on south-facing slopes, because of higher insolation, the upper limit is approximately 4500 feet. On south and southwest slopes of the Rocky Mountain Trench and on the steep west-facing valley sides of the trench, Douglas-fir usually forms the climax forest up to approximately 5700 feet above sea level. For most of the Interior Douglas-fir zone in the map area, lodgepole pine and trembling aspen are the common seral species following fires and other soil disturbances. This holds true for large tracts of drumlinized basal till soils (Kinbasket Association) within the trench where virtually stagnant stands of lodgepole pine were observed. Repeated and often severe forest fires, particularly when

they occur in areas of soils derived from non-acid, medium textured deposits often result in successional stands dominated by trembling aspen. On the dry benches of the main trench, the combined effect of repeated fires, grazing, and high lime content of the soil has resulted in a grassland type of vegetation.

In the absence of fire, and following logging or clearing, trembling aspen and Douglas-fir may become re-established. The re-establishment of Douglas-fir is slow and may be further delayed by the relatively rapid establishment of trembling aspen. The latter species was observed on some moister Luvisolic soils*. In the lower part of the Douglas-fir zone, the establishment of grasses such as blue bunch wheat grass, Idaho fescue and pine grass is favoured both by droughty conditions and high lime content in soils. Such conditions further retard re-establishment of Douglas-fir.

In addition to Douglas-fir and trembling aspen, ponderosa pine and western larch occur as seral species following fire in parts of the lower Findlay Creek valley. In this area mixed stands of all the above mentioned tree species occur.

1.83 SUBALPINE ENGELMANN SPRUCE-ALPINE FIR FOREST ZONE

In this zone variable proportion of Engelmann spruce and alpine fir form the climatic climax forest. Nearly pure stands of Engelmann spruce are restricted to the edaphically wetter locations, while alpine fir often dominates the drier sites. Although Engelmann spruce has a somewhat lower shade tolerance than alpine fir, the latter tends to pioneer after fires due, perhaps, to the greater resistance of alpine fir to wind and other adverse exposures. A combination of relatively well drained soils and adverse exposures often results in a predominance of alpine fir at the upper parts of the Subalpine Engelmann spruce-alpine fir zone, especially just below tree-line. Wherever the hardier alpine fir provides shelter, Engelmann spruce successfully regenerates in available openings but due to severity of climate at uppermost elevations, never attains well grown status.

The Subalpine Engelmann spruce-alpine fir forested subzone extends from the upper limit of the western hemlock-western red cedar zone (4500-5600 feet) or Interior Douglas-fir zone (about 4000 feet) in the West and East Kootenays respectively to about 7500-7900 feet. The upper limit in the West Kootenay and Arrow Lakes area is slightly higher on southwest-facing slopes than on those slopes facing northeast. In the East Kootenays, the lower elevation limit of this subzone is sometimes about 3500 feet in cool tributary valleys influenced by the cold air draining from glaciers, but more often the lower boundary is 4000 feet.

Lodgepole pine is the main fire-succession species in the subzone, especially in the East Kootenays. Usually willows, Engelmann spruce and alpine fir will re-occupy sites following other forms of site disturbance. On wetter soil areas, dense growths of alder or herbaceous plants (or both) inhibit the establishment of coniferous tree species.

The narrow krummholz (crooked wood) subzone, an area in which tree growth is stunted and alpine plant communities are interspersed between islands of trees, occurs at about 6300 feet near glaciers and between 7900 to 8300 feet elsewhere. However, the width and elevation of this subzone varies considerably. This variation may be due to the depth of soil, degree of exposure to wind, sun and frost, and the depth and duration of the snow cover. Other species of trees associated with this sub-zone are alpine larch and whitebark pine. They, however, have limited occurrence within the Lardeau map area.

* For description of these soils, see Chapter Three.

1.84 ALPINE TUNDRA ZONE

The alpine tundra zone is found on exposed mountain slopes generally above 8300 feet elevation. The zone may extend downwards below 6500 feet in snow chutes and on sites affected by cold air draining from glaciers.

The alpine tundra zone is characterized by the absence of alpine fir, Engelmann spruce, western hemlock or other trees. Only some hardy shrubs, mainly low-growing willows and alpine plant species that can mature and set seed rapidly, are adapted to the extremely short growing season, and can survive long cold winters. In many locations, exposed rock with glaciers and talus predominate.

chapter two

SOIL SURVEY AND MAPPING METHODS

SOIL SURVEY AND MAPPING METHODS

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2 SOIL SURVEY AND MAPPING METHODS

2.1 MAPPING METHODOLOGY

The physiographic region (Holland, 1964) provides the initial physical stratification on a regional level. Within these natural regions, erosional and depositional processes, bedrock, erosion and mountain history are similar. The regions are subdivided into forest zones (climatic climax tree species) which reflect macroclimate.

The forest zones (and sometimes subzones) are then subdivided at the local level on the basis of surficial geologic deposits, landforms and bedrock. This local stratification forms the framework of the soil association, the basis on which the soils were mapped (see Figure 9). By definition, a soil association is composed of related soil subgroups that have developed on similar soil parent materials and under similar climatic conditions (in this case, as expressed by vegetation). When interpreted as an expression of climate, the forest zone becomes a useful mapping tool which provides additional boundary limits for each soil association. In areas of limited access with few climatic stations, the extent of an association is often determined by air photo interpretation of vegetation and landform patterns extrapolated from relatively few point data sources. This linkage between forest zone, inferred climate and soil association provides a sound ecological basis for land use planning.

A further stratification used in this survey area was subdivision of the soil association into soil association components based on observed (or inferred) distribution of various soil subgroup profiles over the landscape. Map units were differentiated according to the occurrence of different proportions of soil subgroup profiles. For each map unit, the identified profiles usually occur in a predictable geographic pattern reflecting topographic position and related drainage conditions on a given landscape. The synthesis of a soil association is depicted in the diagram below.

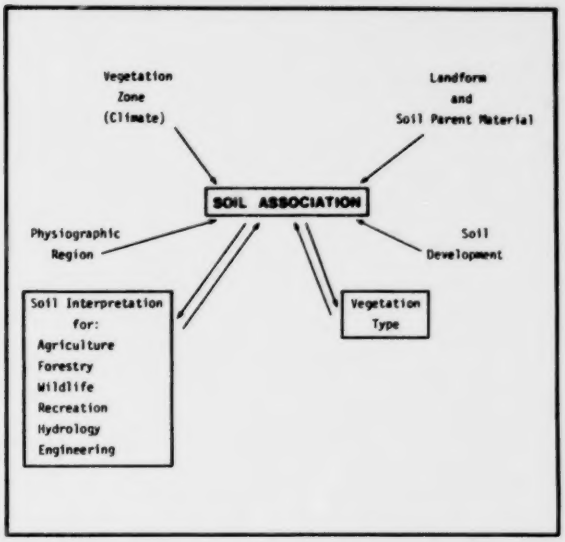

Figure 8: Soil association synthesis

The dominant soil of a soil association component generally consists of one (or sometimes two) soil subgroup of a soil great group and usually occupies the major part of the soil association component. In some exceptions, as in the case of the Avis Association, soil subgroups of more than one great soil group occur together.

Significant soils of a soil association component include soil subgroups of other soil great groups and/or seepage phases. They represent an important part of the soil association component but do not singly or combined, occupy the majority. The seepage phases represent seepage sites and include gleyed variations of the appropriate dominant and significant soils within a soil association.

On uniform soil parent material, the basic mapping unit (soil association component) is sometimes equivalent to a soil series, but generally the mapping unit consists of two or more soil subgroups.

PHYSIOGRAPHIC REGION	FOREST ZONES	SURFICIAL MATERIALS		SOIL ASSOCIATION		DOMINANT SOIL SUBGROUP CLASSIFICATION
				NAME	SYMBOL	
Southern Plateau and Mountain Area	Interior western hemlock - western red cedar zone	Shallow colluvium derived from, and overlying bedrock	coarse grained bedrock	Buhl Creek	BH	Orthic Dystric Brunisol
				Bergman	BR	Orthic Humo-Ferric Podzol
			medium grained bedrock	Bohan Creek	BK	Orthic Dystric Brunisol
				Blaylock	BY	Orthic Humo-Ferric Podzol
			fine grained bedrock	Blizzard	BZ	Orthic Dystric Brunisol
				Burkitt	BM	Orthic Humo-Ferric Podzol
		Deep colluvial deposits	coarse textured colluvium	Cooper	CP	Orthic Dystric Brunisol
				Comaplix	CX	Orthic Humo-Ferric Podzol
				Curtis	CT	Sombric Humo-Ferric Podzol
			medium textured colluvium	Calamity	CL	Orthic Dystric Brunisol
				Cataract	CE	Orthic Humo-Ferric Podzol
				Mont Cond	CS	Sombric Humo-Ferric Podzol
		Glacial till deposits	coarse textured till	Slocan	SN	Orthic Dystric Brunisol
				Stobart	SR	Orthic Humo-Ferric Podzol
			medium textured till	Sentinel	SL	Orthic Dystric Brunisol
				Stubbs	SB	Orthic Humo-Ferric Podzol
				Steenhoff	SF	Luvisolic Humo-Ferric Podzol
		Glaciofluvial deposits	sandy glaciofluvial deposits	Gillis	GS	Orthic Dystric Brunisol
			coarse textured glaciofluvial ice contact (kames) and terrace deposits	Kaslo	KO	Orthic Dystric Brunisol
				Kuskanax	KX	Orthic Humo-Ferric Podzol
		Fluvial deposits	fluvial fan deposits	Fruitvale	FT	Orthic Dystric Brunisol
			recent fluvial deposits (floodplain)	Avis	AS	Orthic Regosol
		Lacustrine deposits	medium and fine textured lacustrine deposits	Lawley	LY	Brunisolic Gray Luvisol
	Subalpine Engelmann spruce - alpine fir zone (forested sub-zone)	Shallow colluvium derived from and overlying bedrock	Coarse grained bedrock	Bluejoint	BT	Orthic Humo-Ferric Podzol
			medium grained bedrock	Beaton Creek	BA	Orthic Humo-Ferric Podzol
			fine grained bedrock	Brouse	BE	Orthic Humo-Ferric Podzol
		Deep colluvial deposits	coarse textured colluvium	Coppercrown	CC	Orthic Humo-Ferric Podzol
			medium textured colluvium	Carney	CY	Orthic Humo-Ferric Podzol
		Glacial till deposits	medium and fine textured till	Sandner	SD	Orthic Humo-Ferric Podzol
			medium textured till	St. Leon	ST	Orthic Humo-Ferric Podzol
			coarse textured till	Swehaw	SH	Orthic Humo-Ferric Podzol
			medium and fine textured till	Sandon	SA	Orthic Humo-Ferric Podzol
	Alpine tundra zone and krummholz subzone of Subalpine Engelmann spruce - alpine fir zone	Shallow colluvium derived from and overlying bedrock	coarse grained bedrock	Beatrice	BC	Orthic Humo-Ferric Podzol
			medium grained bedrock	Bonner	BO	Orthic Humo-Ferric Podzol
			fine grained bedrock	Burn Creek	BU	Orthic Humo-Ferric Podzol
			variable grained bedrock	Rossland	RL	Sombric Humo-Ferric Podzol
		Deep colluvial deposits	coarse textured colluvium	Clifty	CF	Orthic Humo-Ferric Podzol
			medium textured colluvium	Champion	CH	Orthic Humo-Ferric Podzol
			variable textured colluvium (talus)	Ymir	YR	Orthic Regosol
Rocky Mountain Trench and Rocky Mountain Area	Interior Douglas fir zone	Shallow colluvium derived from and overlying bedrock	calcareous bedrock	Big Fish	BF	Orthic Eutric Brunisol
		Deep colluvial deposits	coarse and medium textured calcareous colluvium	Cervil	CR	Orthic Eutric Brunisol
		Glacial till deposits	coarse and medium textured calcareous till	Wycliffe	WY	Orthic Eutric Brunisol
				Kinbasket	KB	Orthic Gray Luvisol
		Fluvial deposits	coarse and medium textured, recent fluvial deposits (floodplain)	Nowitka	NW	Orthic Regosol
			coarse and medium textured, fluvial fans	Fairmont	FA	Orthic Eutric Brunisol
		Glaciofluvial deposits	coarse textured glaciofluvial ice contact and terrace deposits	Keeney	KE	Orthic Eutric Brunisol
		Lacustrine deposits	medium and fine textured lacustrine deposits	Mayook	MY	Orthic Eutric Brunisol
	Subalpine Engelmann spruce - alpine fir zone (forested subzone)	Shallow colluvium derived from and overlying bedrock	coarse and medium grained bedrock	Brennan	BB	Orthic Dystric Brunisol
				Bunyon	BP	Orthic Humo-Ferric Podzol
			calcareous bedrock	Badshot	BS	Orthic Eutric Brunisol
		Deep colluvial deposits	coarse and medium textured colluvium	Coubrey	CB	Orthic Dystric Brunsol
			variable textured colluvium	Conrad	CN	Orthic Humo-Ferric Podzol
			medium textured, calcareous colluvium	Couldron	CW	Orthic Eutric Brunisol
			variable textured colluvium (talus)	Yahk Creek	YK	Orthic Regosol
		Glacial till deposits	medium textured, calcareous till	Spillimacheen	SP	Orthic Eutric Brunisol
		Glaciofluvial deposits	coarse textured glaciofluvial ice contact (kames) and terrace deposits	Kingcome	KG	Orthic Humo-Ferric Podzol
		Lacustrine deposits	medium and fine textured lacustrine deposits	Linten	LI	Orthic Humo-Ferric Podzol
	Alpine tundra zone and krummholz subzone of Subalpine Engelmann spruce-alpine fir zone	Shallow colluvium derived from and overlying bedrock	variable grained bedrock	Radium	RA	Degraded Melanic Brunisol

Figure 9: Key to the soils of the Lardeau map area and their relation to physiography, forest zone, parent material and soil classification

Map units are delineations on the map and have symbols which identify the soil association components therein. These components consist of the soil association abbreviation plus a subscript number, e.g. KO_1, KO_2. The soil association components contain relative proportions of dominant and significant soils explained earlier. Dominant soils usually occupy over 50% of the component while the significant soils occupy the remainder.

Two (or three) different soil association component symbols occur on map units where the individual components are present in arrangements too complex to delineate separately at the scale of mapping. Their area in the map unit is expressed as a proportion (on a scale of 1 to 10) of the total area of the map unit and is indicated as a superscript. Thus, a map unit designated as SN_1^7 - KO_1^3 contains about seven-tenths (70%) of SN_1 soil association component and about three tenths (30%) of KO_1 soil association component.

2.2 FIELD PROCEDURES AND ACCESS

Field mapping was conducted at a reconnaissance scale using aerial photographs (approximate scale of 1" = 1 mile). Most map delineations were determined by air photo interpretations as there was limited ground access in much of the area. After field checking, the boundaries were then transferred to 1:50 000 base maps for soil map compilation. These maps were subsequently reduced to four 1:100 000 maps and are part of this report.

The soils and landforms were examined and described as were the topography, surficial materials, vegetation, land use and other related characteristics. Representative soil profiles were described in detail, sampled and analyzed. The soils were classified according to the Soil Classification System for Canada (Canada Department of Agriculture Publ. 1455, 1970 as amended in 1973).

Field checking in accessible areas involved traversing all available roads and trails. However, site investigations in mountainous areas were generally limited to a few selected stops by helicopter.

Map accuracy (in relative terms) is dependent on ease and availability of access for field checking. Portions of the map area considered to have the highest relative accuracy and dependability are those in which adequate ground access was possible. In other areas where the map was compiled primarily by extrapolation, its accuracy probably decreases in proportion to the distance between traverse lines. Areas that were surveyed by helicopter are considered to have the lowest accuracy, as only spot checks were made. An estimation of the relative reliability of any portion of the map can be obtained by referring to the access map (Figure 10).

2.3 THE SOIL MAP

The soil map of the Lardeau Area is printed on four sheets at a scale of 1:100,000. Site specific data is not shown and these maps should not be used in lieu of actual site inspection when necessary. However, the information provided is useful for general assessments and can serve as an effective guide for planning and management.

Each map delineation is identified by a map symbol which is composed of two parts. The upper part (numerator) indicates the soil association component either singly or in combination. The lower part (denominator) identifies the soil parent material, landform (surface expression) and slope gradient. All symbols used on the maps are described in the attached legend. An example of a typical map symbol is shown below:

Figure 10: Access of the Lardeau map area

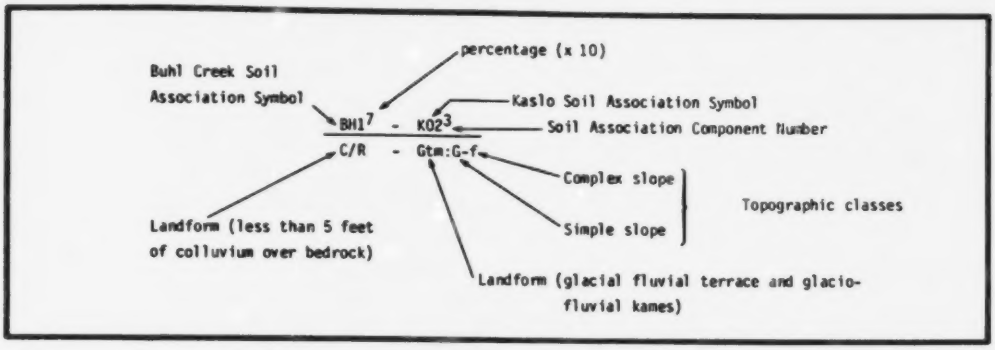
percentage (x 10)
Buhl Creek Soil Association Symbol
Kaslo Soil Association Symbol
Soil Association Component Number
BH1 7 - K02 3
C/R - Gtm:G-f
Complex slope
Simple slope
Topographic classes
Landform (less than 5 feet of colluvium over bedrock)
Landform (glacial fluvial terrace and glacio-fluvial kames)

Figure 11: Example of soil map symbol

Lardeau Area Maps		Equivalent Symbol to Terrain System	
A. GENERAL ORIGIN OF LANDFORM	SYMBOL	DESCRIPTION TERMINOLOGY	SYMBOL
Eolian	E	Eolian	E
Colluvium	C	Colluvium	C
Fluvial (alluvial)	F	Fluvial	F
Glacial Fluvial	G	glaciofluvial	F^G
(Glacial) Lacustrine	L		
Glacial Till - Basal	T		
Glacial Till - Ablation	A	Morainal	M
Glacial Till - Steepland	S		
Bedrock	R	Bedrock	R
Organic	O	Organic	O
B. SURFACE FOR OR PATTERN OF LANDFORMS	SYMBOL	SURFACE EXPRESSION	SYMBOL
Beach	b		
Channelled (ridge and swale)	c		
Delta	a		
Drumlin(ized)	d		
Dune(d)	n		
Eroded (active) or Dissected (non-active)	v		
Esker(s), crevasse filling	e	ridged	r
Fan	f	fan	f
Fluted	u		
Hummocky	h	hummocky	h
Kame	m		
Kettle (d)	k		
Plain	p		
Talus Cone	r		
Terrace	t	terrace	t
Slump(ed)	s		
Meltwater channel	w		

Overlays are indicated with a slash(/)

Figure 12: Landform symbolling system and the terrain system equivalent

chapter three

SOILS OF THE LARDEAU MAP AREA

SOILS OF THE LARDEAU MAP AREA

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3 SOILS OF THE LARDEAU MAP AREA

3.1 DOMINANT FEATURES RELATED TO SOIL FORMATION

The main soil forming processes believed active in the map area are the following:

3.11 DEVELOPMENT OF DYSTRIC BRUNISOL AND PODZOLIC B HORIZONS

Plate 14

Formation of brunisolic and podzolic B horizons is a dominant feature of the soil forming processes active throughout most of the Lardeau map area. Podzolization is a weathering and leaching process which depletes soils of cations producing a more acidic soil with light coloured surface layers above iron, aluminum and organic matter enriched reddish-brown subsoil layers. The intensity of this weathering process is primarily a function of climate (effective precipitation and temperature). Dystric Brunisol (Plate 14) and Podzol soils have similar weathering processes, however, weathering has been less intense in Dystric Brunisols and they do not meet the chemical and morphological criteria of Podzols.

The five soils shown in Figure 13 have all developed from a thin mantle of colluvium overlying medium-grained bedrock and all are at various degrees of podzolic development. Iron and aluminum oxidation and translocation is least in the Bohan Creek soil which has relatively low rates of weathering, low amounts of precipitation and generally higher soil temperatures throughout the year. Increased podzolization increases the rate of iron and aluminum oxidation and produces reddish-brown colours in Bf horizons. In Humo-Ferric Podzol soils (shown in Plates 15 and 16) the B horizon is more strongly oxidized, weathered, and reddish-brown in colour.

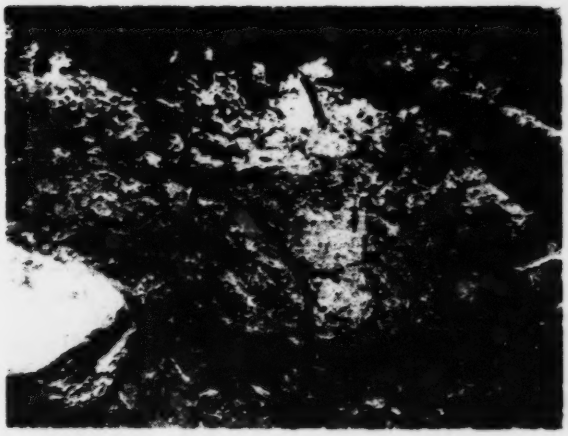


Plate 15

In addition to the above mentioned processes, organic matter in various humus forms is transferred downward from the A to the B horizons of Podzol soils (and to a lesser extent in Dystric Brunisols). When organic matter accumulation in the Bf horizons exceed a total carbon content of 5%, the horizons are termed Bhf (see Rossland soils).

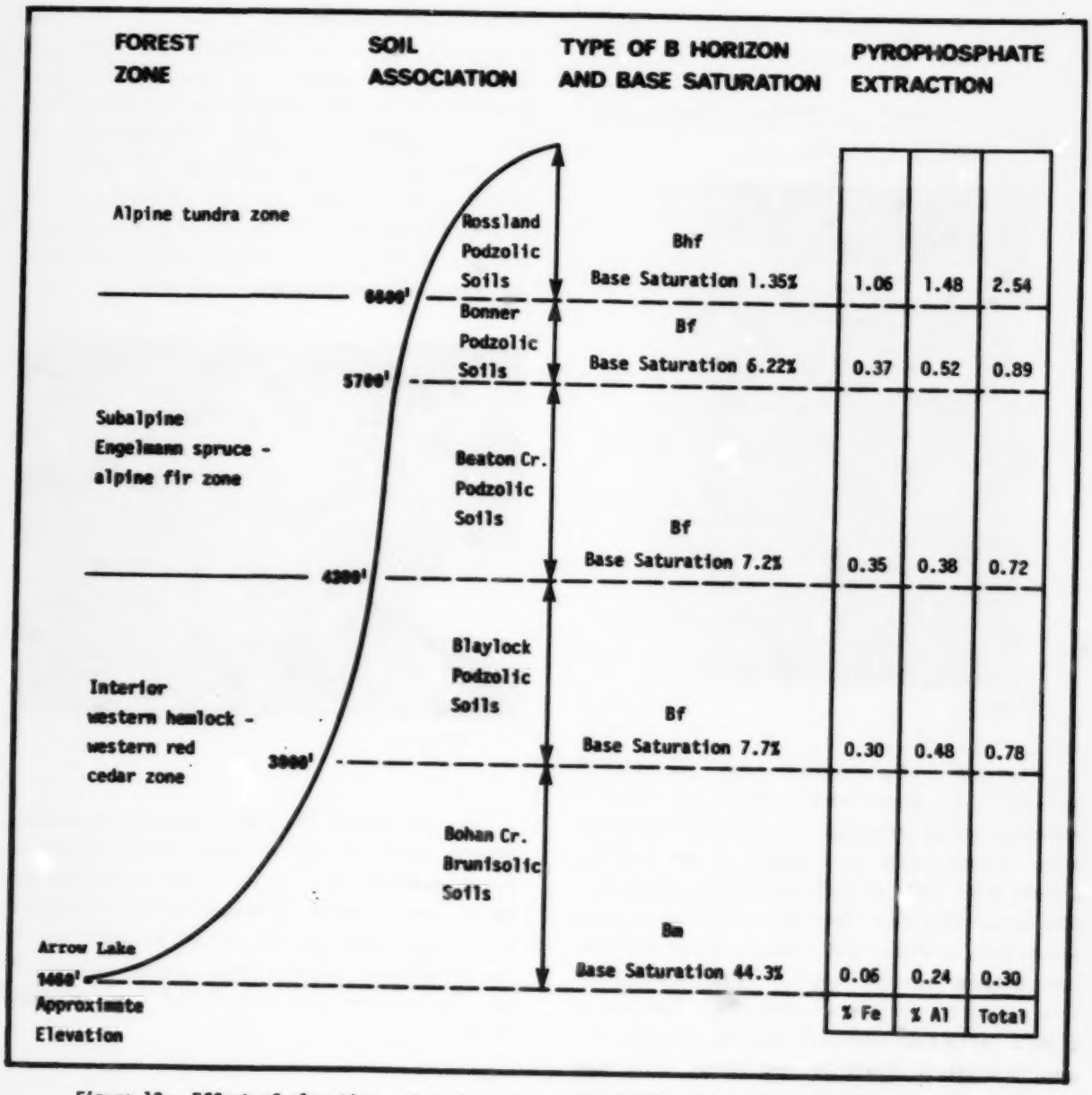


Figure 13: Effect of elevation and environment on the development of Bm, Bf and Bhf horizons

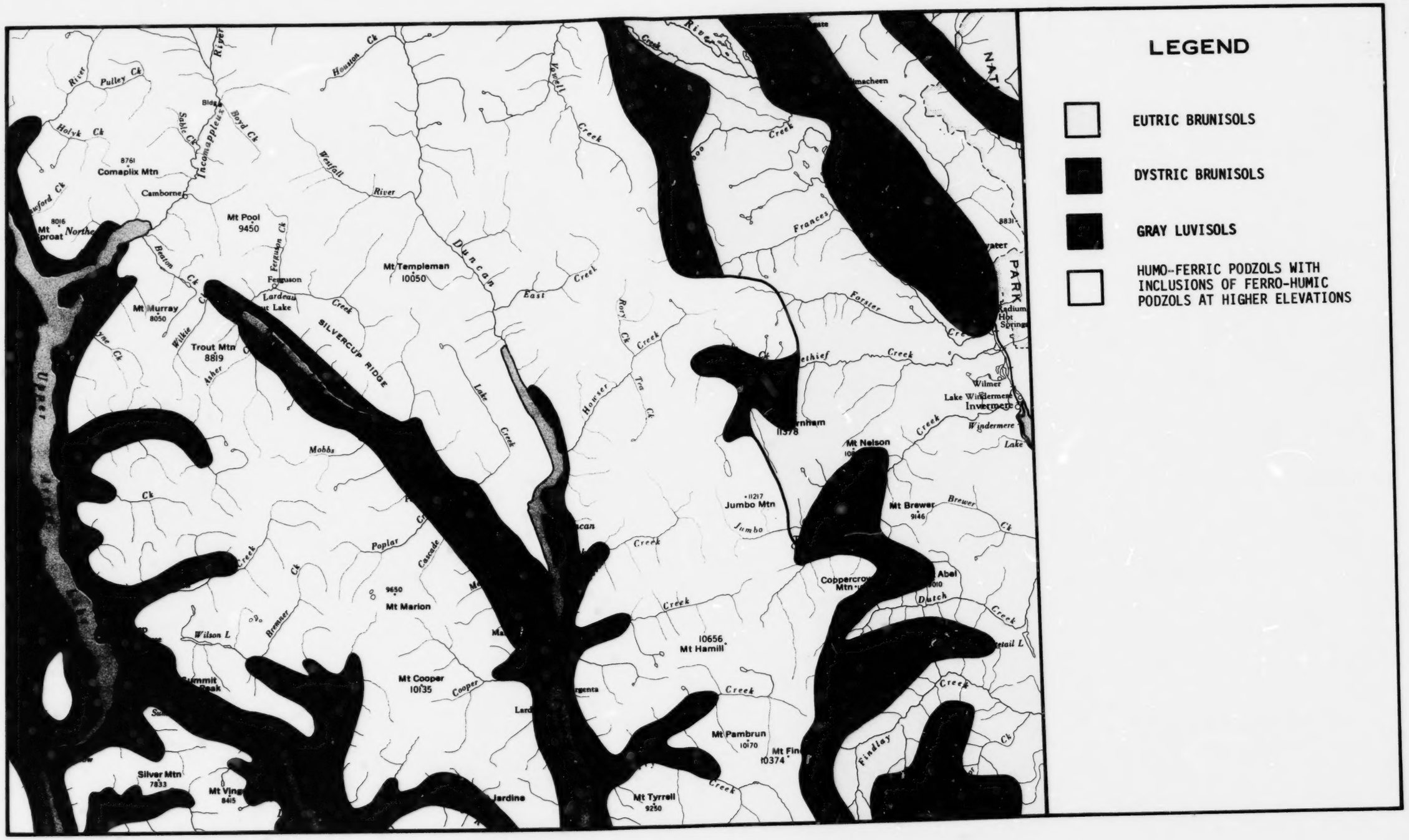


Figure 14: Major soil development of the Lardeau map area

Plate 16

3.12 DEVELOPMENT OF Bt HORIZONS

The occurrence of well-developed clay accumulation (Bt) horizons is limited to some soils which have developed from medium or fine-textured parent materials. The formation of Bt horizons involves mainly a physical movement of clay. Over long periods of time and after leaching of excess lime, water percolating through the soil removes clay particles from the upper horizons (eluviation) and re-deposits them in the horizons below (illuviation). This process is well represented in soils of the Steenhoff, Lawley and Kinbasket associations.

Most soils, however, in the Lardeau map area are fairly coarse textured, and range from gravelly sandy loam to gravelly silt loam. Generally, there is not enough clay in these soils to form well-developed clay accumulation horizons. Limited clay accumulation is indicated by the presence of discontinuous coatings of clay (clay skins) in the pores and cleavages through which water moves. The presence of weakly developed Bt horizons is acknowledged by the inclusion of Gray Luvisol soils as significant components of the appropriate soil associations.

A practical significance of well-developed Bt horizons is that they tend to restrict downward water movement and small root penetration. The general lack of well defined Bt horizons in the mountainous soils of this map area may be attributed to a combination of relatively coarse soil textures and very slow and continuous downslope mass movement which tends to disrupt Bt horizon formation.

3.13 DURIC HORIZONS IN SOME SOILS OF THE LARDEAU MAP AREA

Duric horizons were recognized in this map area. These moderately to strongly-cemented horizons occur in the moderately coarse-textured Slocan, St. Leon and Stobart soil associations. Excellent examples of duric horizons can be found in the general area north of Nakusp within the Halfway River drainage, at elevations near 5500 feet. Plate 17 shows a typical example of duric horizons.

Plate 17

Very extensive and thick duric horizons are probably disadvantageous for excavation,but since

they generally occur below the rooting zone, no significant forest growth restrictions were observed. In fact, forest growth probably benefits in that water percolation is impeded and remains in the root zone for longer periods.

3.14 THE ROLE OF GROUND AND SEEPAGE WATER

Gleysolic soils are poorly drained and occur mostly in depressional areas. For varying periods throughout the year the excess soil water causes mottling and reducing conditions with limited soil aeration. These conditions are prevalent in some components of the Avis and Nowitka Soil Associations.

Periodic water-logged soil conditions also occur on sloping mountainous terrain in seepage areas. Since the regular classification criteria for Gleysolic or gleyed soils are not well expressed in these site specific wet areas, they were termed "seepage phases" of the appropriate dominant soil association. The seepage sites are characterized by lush deciduous vegetation and have resulted in a high buildup of organic matter in the soil. The seepage waters contain high amounts of dissolved oxygen and nutrients; they usually occur at specific sites where melt and runoff waters from higher elevations accumulate. Typical seepage sites are shown in Plates 18 and 19.

Plate 18

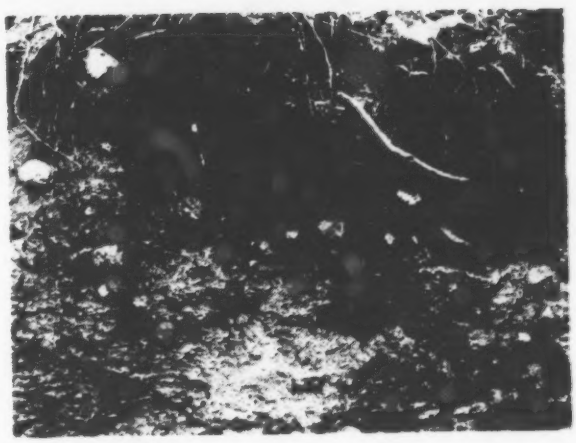


Plate 19

3.2 CHEMICAL PROPERTIES OF THE LARDEAU MAP AREA SOILS

Various chemical analyses were made on samples of some of the soil associations as indicated in Appendix G. As sampling intensity was limited, the analyses serve only as a guide for broad soil characterization. More sampling is needed to properly assess fertility status and to make recommendations. The following general statements are based on the limited soil chemical data that are available.

3.21 GENERAL pH (REACTION) CHARACTERISTICS

Soil parent materials east of the Purcell Divide generally have neutral to alkaline pH values because of their high contents of lime. These pH's generally range from 7.5 to 8.0 (0.1M $CaCl_2$). Solum pH's are somewhat lower, usually ranging from weakly acid to neutral depending on the degree of leaching and original lime content.

West of the Purcell divide, lime in the soils is not as prevalent and solum pH's of most Dystric Brunisol soils range from about 4.9 to 5.7 (0.1M $CaCl_2$). Higher amounts of precipitation at the upper elevations in the same general area has increased the leaching and acidity. The resultant pH's of the Humo-Ferric Podzol soils range from about 4.2 to 5.1 (0.1M $CaCl_2$).

Soils in seepage areas east of the Purcell Divide generally have higher pH's than those in adjacent well drained sites. Lime is continually introduced by incoming water, and the soil reactions are usually mildly alkaline.

3.22 EXCHANGEABLE CATIONS, EXCHANGE CAPACITY AND BASE SATURATION

Exchangeable cations (or bases) refer to the dominant cations (calcium, magnesium potassium and sodium) which are attracted to and held by the negative charges on soil mineral and organic particles.

The Cation Exchange Capacity (CEC) is a measure of the total exchangeable bases the soil is capable of attracting and holding. Most of the bonding sites are associated with clay and organic material. If the capacity of the soil to hold bases is measured, and the actual amount of bases present in the soil is determined, the two together give a measure of the base saturation of that soil.

The cation exchange capacities are highly variable in the Lardeau map area soils. The highest CEC'sin mineral soils occur in the A and B horizons and range from about 10 to 30 meq/100 g soil. Most lower elevation forested soils have low to medium values in the C and B horizons respectively. Higher CEC (ranging from about 40-55 meq/100 g soil), due to higher amounts of organic matter, are found in the sola of the Rossland and Radium soils.

Coarse-textured soils such as Gillis, Kaslo and Nowitka soil associations have very low CEC's that range from about 1 to 9 meq/100 g soil. This is due to the dominance of sand and gravel particles in these soils.

3.3 DESCRIPTION OF SOIL ASSOCIATIONS

The individual soil associations of the Lardeau map area are described in the following pages. Also included are schematic cross-sectional diagrams and tables identifying the soil association components. The diagrams depict the physiographic setting and show the relationship between soil profile development, vegetation, landform, type of soil parent material and elevation.

The soil developments are indicated in standard abbreviated form. Dominant soil subgroups are shown without parentheses while the significant soil subgroups and phases are shown with parentheses.

The vegetation symbols do not necessarily include the full range of tree species which may occur, but rather, indicate the tree species commonly found during the survey. The reader is referred to fold out Figure 15 that defines the abbreviations and the pictoral symbols on the cross-sectional soil association diagrams and in the tables.

Key to Soil Associations

Abbreviations for Soil Drainage

r	-	rapidly drained
w	-	well drained
rw	-	rapidly to well drained
mw	-	moderately well drained
i	-	imperfectly drained
p	-	poorly drained
v	-	very poorly drained

Abbreviations for Soil Classification

O.DB	Orthic Dark Brown
O.DG	Orthic Dark Gray
O.GL	Orthic Gray Luvisol
BR.GL	Brunisolic Gray Luvisol
GL.GL	Gleyed Gray Luvisol
O.EB	Orthic Eutric Brunisol
DG.EB	Degraded Eutric Brunisol
L.EB	Lithic Eutric Brunisol
LDG.MB	Lithic Degraded Melanic Brunisol
DG.MB	Degraded Melanic Brunisol
L.SB	Lithic Sombric Brunisol
O.SB	Orthic Sombric Brunisol
O.DYB	Orthic Dystric Brunisol
L.DYB	Lithic Dystric Brunisol
DG.DYB	Degraded Dystric Brunisol
DU.DYB	Duric Dystric Brunisol
O.HFP	Orthic Humo-Ferric Podzol
L.HFP	Lithic Humo-Ferric Podzol
GL.HFP	Gleyed Humo-Ferric Podzol
SM.HFP	Sombric Humo-Ferric Podzol
LU.HFP	Luvisolic Humo-Ferric Podzol
DU.HFP	Duric Humo-Ferric Podzol
O.FHP	Orthic Ferro-Humic Podzol
L.FHP	Lithic Ferro-Humic Podzol
SM.FHP	Sombric Ferro-Humic Podzol
O.R	Orthic Regosol
GL.OR	Gleyed Orthic Regosol
CU.R	Cumulic Regosol
O.G	Orthic Gleysol
O.HG	Orthic Humic Gleysol

Standardized Vegetation Symbols

Tree layer - coniferous

- deciduous

- krummholz

Species symbols as prescribed in C.L.I. Guidelines for Mapping (1970) are entered in the circles in each vegetation symbol.

tA	trembling aspen
wB	white birch
wC	western red cedar
bCo	black cottonwood
D	Douglas-fir
alF	alpine fir
wH	western hemlock
wL	western larch
lP	lodgepole pine
pP	ponderosa pine
wP	western white pine
eS	Engelmann spruce
wS	white spruce

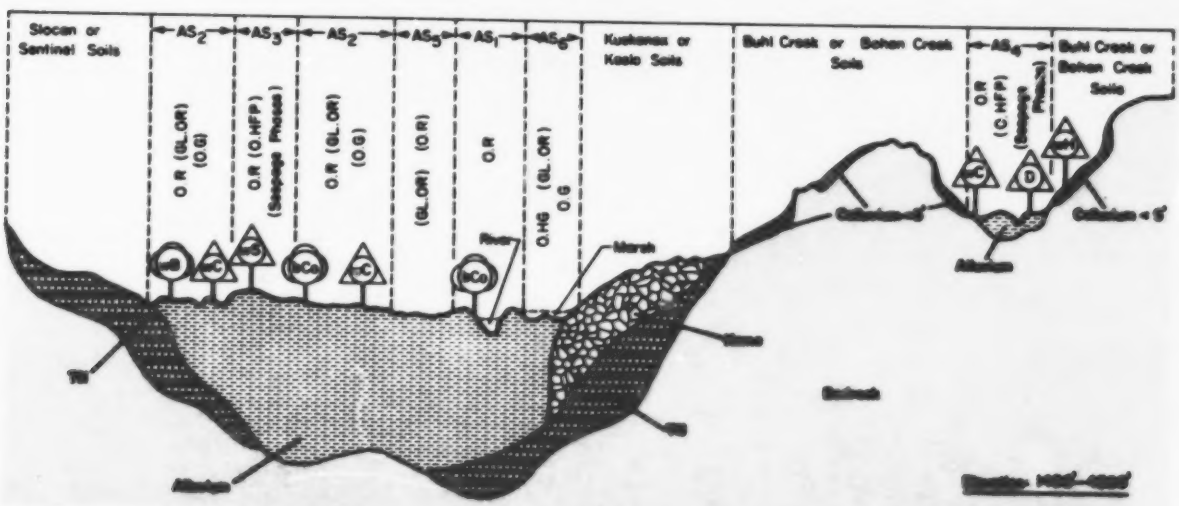
Figure 15: Abbreviations used in the soil association descriptions

AVIS ASSOCIATION (AS)

Avis soils are usually found on recent flood-plain deposits in the Incomappleux, Duncan and Lardeau River valleys. The topography is usually undulating but may vary to rolling, near back channels and old meanders.

Avis soils are usually medium textured, but may include alternating layers of gravel, fine-textured sediments and organic material. The dominant textures, however, are sandy loam or silt loam. Soil development is generally Regosolic although other types of profiles are also present. Where these soils lie above and away from the stream's edge and are least influenced by ground water or flooding, they have either Orthic Dystric Brunisol or Orthic Humo-Ferric Podzol soil development. Conversely, in low-lying areas influenced by ground water and frequent flooding, Gleyed Regosols or Gleysols, often calcareous, have developed.

A variety of plant species occur on these



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Avis	AS1	Orthic Regosol	r,w	.....		medium to moderately coarse textured alluvium	1400-4500	interior western hemlock - western red cedar
	AS2	Orthic Regosol	r,w	Gleyed Orthic Regosol Orthic Gleysol	i p,v			
	AS4	Orthic Regosol	r,w,	Orthic Humo-Ferric Podzol seepage phases	w i			
	AS5	Gleyed Orthic Regosol	i	Orthic Regosol	r,w			
	AS6	Orthic Humic Gleysol	p,v	Gleyed Orthic Regosol Orthic Gleysol	i p,v			

soils and reflect the variation in soil moisture. The main trees are usually western red cedar, western hemlock, black cottonwood, birch and alder. The annual precipitation varies from about 25 to 45 in./annum and the frost-free period ranges up to 150 days.

Most of the Avis soils are presently being used for agriculture. They are well suited for hay production and a wide range of climatically suited crops is possible on the well and imperfectly drained parts of this soil association. Irrigation during the summer is often required for above average crop yields.

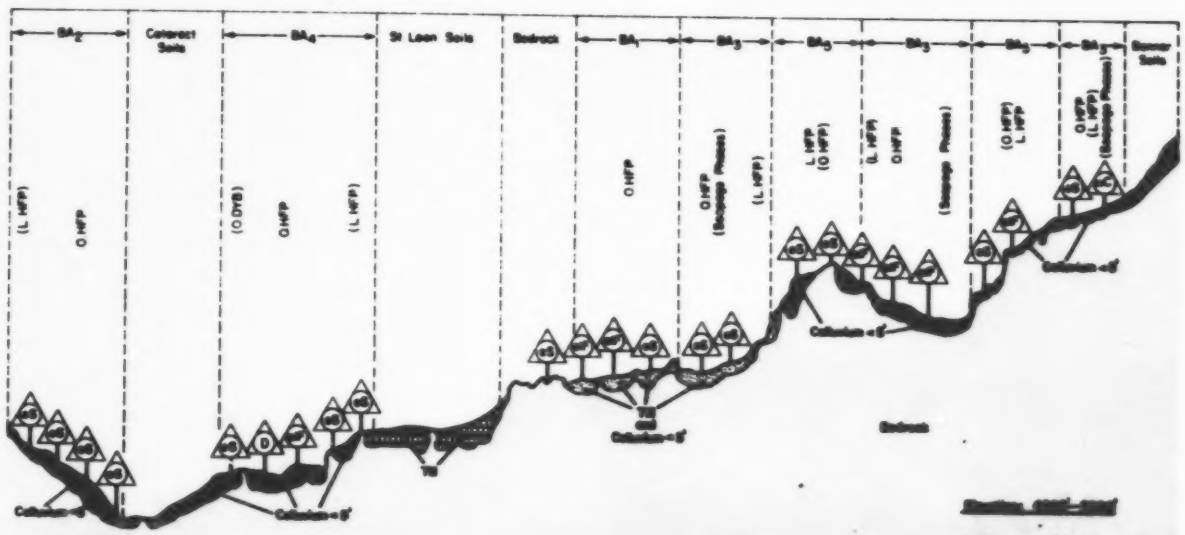
These soils are highly productive for forestry. The proximity of the water table and the generally favourable climate make these soils well suited for the tree species indicative of the western hemlock-western red cedar forest zone. It is possible to attain mean annual increments in excess of 250 cubic feet per acre per year for black cottonwood.

Avis soils have moderately high values as ungulate winter range in areas where snow depth is not excessive.

BEATON CREEK ASSOCIATION (BA)

Beaton Creek soils are located mainly in the West Kootenay part of the Lardeau map area and are common in the Lardeau, Duncan and Incomappleux drainage basins. They have primarily developed in colluvium which is less 5 ft. thick and is derived from medium-grained bedrock (argillite and argillaceous quartzite). They occupy the upper forested mountain slopes and some ridge crests. The landform surface reflects the slope of the underlying bedrock which is generally greater than 30%.

Beaton Creek soils are dominantly Humo-Ferric Podzols. Typically, the solum is about 20 inches thick, sandy loam in texture and contains a moderate amount of stones. Lithic subgroups (less than 20 in. to bedrock)are prevalent. Map units in the lower parts of the elevational range, as well as those that occur on southwesterly aspects, contain a significant proportion of Dystric Brunisols. Generally, seepage phases occur at the higher elevations and are more evident on northeast facing slopes. The soils are strongly to very strongly acid and base saturation is low. Elevations range from 4000 to 5800 feet. Beaton Creek soils are well drained except for seepage and lithic phases which are imperfectly and rapidly drained respectively.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Beaton Creek	BA1	Orthic Humo-Ferric Podzol	w	.....		shallow, medium to moderately coarse textured colluvium overlying medium-grained bedrock	4000-5800	Subalpine Engelmann spruce - alpine fir
	BA2	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	r,w			
	BA3	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	r,w			
	BA4	Orthic Humo-Ferric Podzol	w	Orthic Dystric Brunisol Lithic Humo-Ferric Podzol	r,w r,w			
	BA5	Lithic Humo-Ferric Podzol	r,w	Orthic Humo-Ferric Podzol	r,w			

Beaton Creek Association (Cont'd)

Engelmann spruce and alpine fir are the dominant tree cover and minor amounts of mountain hemlock, lodgepole pine and alpine larch are present at the upper elevations. Ground cover includes mountain huckleberry, bunchberry, false box and one-sided wintergreen. Substantial summer precipitation and heavy snowfall in the winter, together with generally cool temperatures, provide adequate soil moisture throughout the growing season.

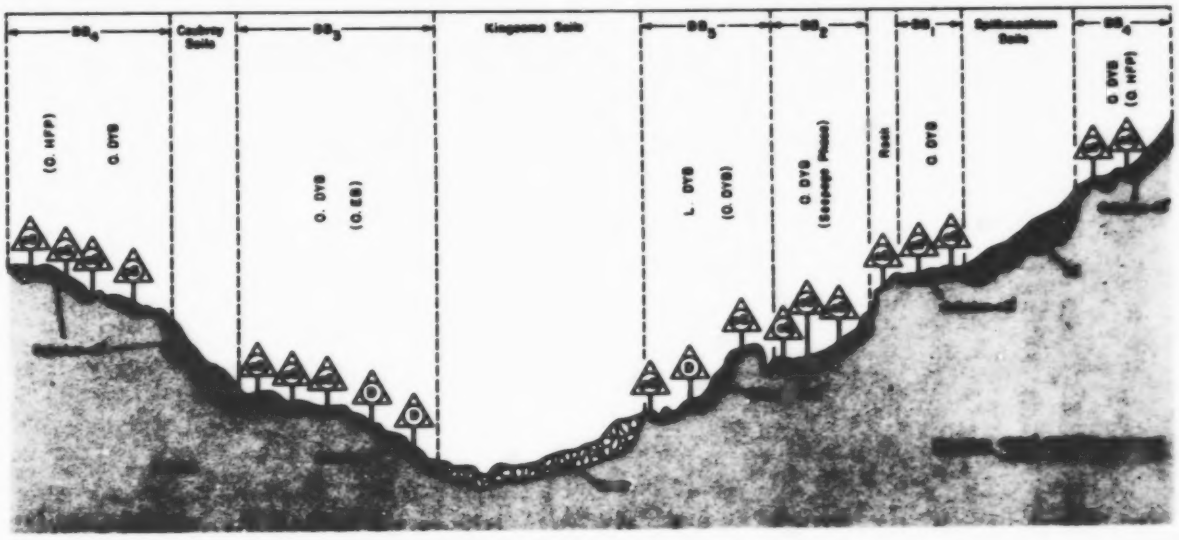
Present land use is mainly forestry. Some logging is underway on more level terrain and on the deeper Beaton Creek soil areas.

BRENNAN ASSOCIATION (BB)

Brennan soils are mapped in the southeastern part of the map area within the Doctor, Findlay, Dutch and Toby Creek drainages. They occur on forested ridges and at middle elevations of long, forested, steep slopes, as well as in some depressional cirque basins. They have developed from a thin mantle (less than 5 ft. thick) of colluvium derived from coarse and medium-grained bedrock (granodiorite, granite, argillite and argillaceous quartzite). Elevations are generally between 4300 and 5500 feet on south aspects and between 4300 and 5200 feet on north aspects.

The main soil development is Orthic Dystric Brunisol. Small inclusions of colluvium associated with calcareous bedrock support Orthic Eutric Brunisol soils. At the higher elevations, Orthic Humo-Ferric Podzols generally occupy minor areas mixed with the modal Orthic Dystric Brunisols. Lithic Dystric Brunisols are prevalent in some areas and consist of less than 20 in. of soil over bedrock.

The soil textures are typically gravelly sandy loam in the solum and gravelly loamy sand in the parent material below. The soils are usually well to rapidly drained owing to the coarseness of their texture. Seepage phases, which are infrequent, are



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Brennan	BB1	Orthic Dystric Brunisol	r,w	.....		shallow, moderately coarse textured colluvium overlying coarse to medium-grained bedrock	4300-5500	Subalpine Engelmann spruce - alpine fir
	BB2	Orthic Dystric Brunisol	r,w	seepage phase	i			
	BB3	Orthic Dystric Brunisol	r,w	Orthic Eutric Brunisol	r,w			
	BB4	Orthic Dystric Brunisol	r,w	Orthic Humo-Ferric Podzol	r,w			
	BB5	Lithic Dystric Brunisol	r	Orthic Dystric Brunisol	r,w			

imperfectly drained.

Vegetation is typical of the Subalpine Engelmann spruce-alpine fir forest zone. The main trees are Engelmann spruce, alpine fir, lodgepole pine, and some western larch and Douglas-fir at the lower elevations. In many cases tree cover is sparse because of the predominance of lithic soils and associated bedrock outcrops. The soils are generally characterized by cold winters and moderately warm summers. The annual precipitation ranges between 15 and 25 inches.

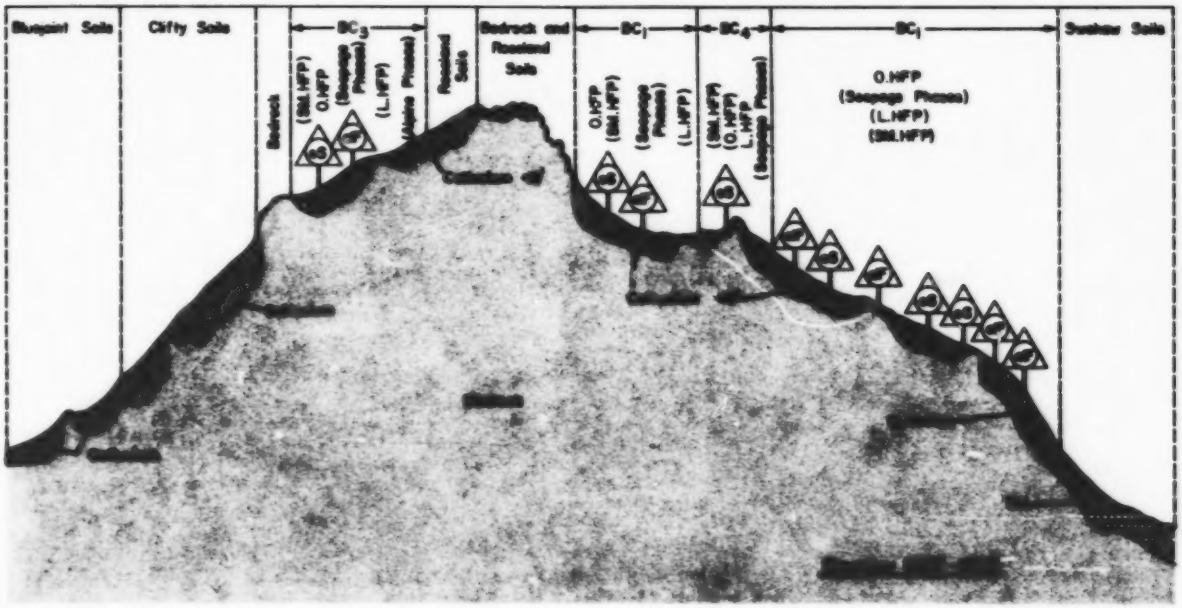
Because of soil moisture deficiency during the growing season and relatively shallow soils, the Brennan Association is generally poor for forest production. Sheltered areas are used by some wildlife species in summer.

BEATRICE ASSOCIATION (BC)

The Beatrice soils occur in the Kuskanax and Fry Creek and Halfway River areas and are confined to mountain ridges, upper elevations of long mountainous slopes and depressional cirque basins. Elevations vary from about 5800 to 6500 feet. They have developed from a thin mantle (less than 5 ft. thick) of colluvium overlying coarse-grained, often strongly fractured acidic bedrock (granite, quartz, granodiorite). Typical soil textures are gravelly sandy loam or gravelly loamy sand.

Typical soil development is Orthic or Lithic Humo-Ferric Podzol and these are well drained. Significant inclusions of seepage phases, as well as Sombric Humo-Ferric Podzol soil development, are typical near timberline. These latter soils occur in sparsely treed or untreed openings in the forest and support alpine plant communities of grasses and forbs.

The soils are acid and have low base saturations. The vegetation is typical of the upper Subalpine Engelmann spruce-alpine fir forest zone. Species include well formed and stunted



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Beatrice	BC1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Sombric Humo-Ferric Podzol seepage phases	w mw i	shallow, moderately coarse to coarse textured colluvium overlying coarse-grained acidic bedrock	5800-6500	Subalpine Engelmann spruce - alpine fir (krummholz)
	BC3	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Sombric Humo-Ferric Podzol seepage phases	w mw i			
	BC4	Lithic Humo-Ferric Podzol	w	Orthic Humo-Ferric Podzol Sombric Humo-Ferric Podzol seepage phases	w mw i			

(krummholz) alpine fir and Engelmann spruce. Some stunted whitebark pine, lodgepole pine and mountain hemlock is found in sheltered locales. Very short frost-free periods and high winter snowfalls are typical.

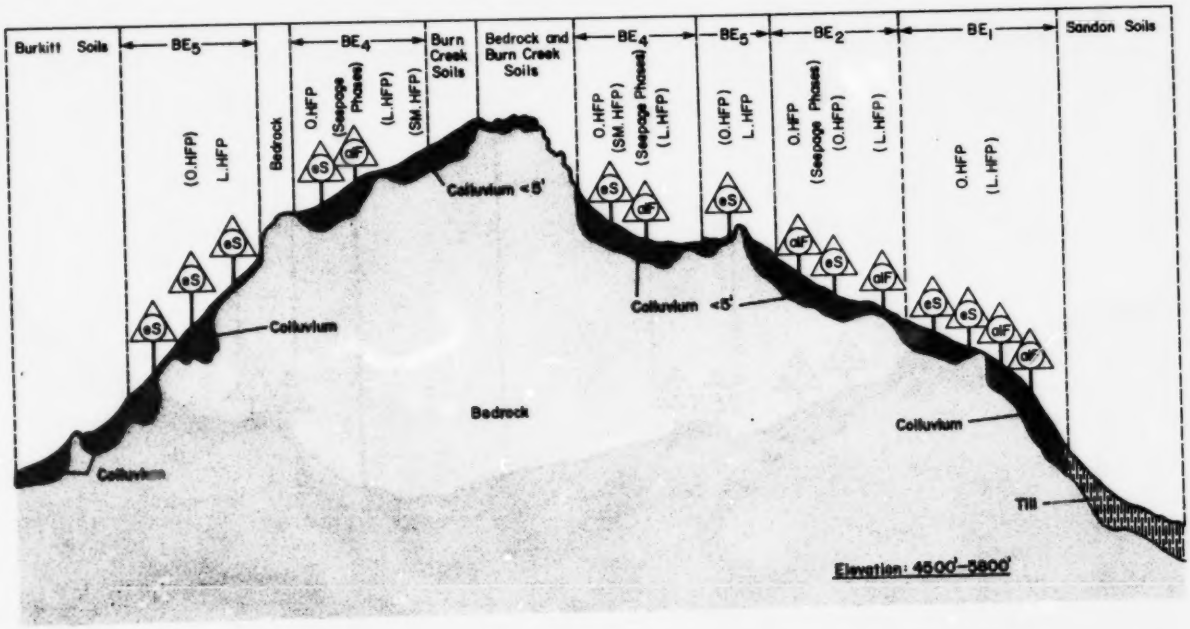
The soils have low capability for forestry, but have wildlife grazing potential near the tree-line and considerable potential for hiking, horseback riding and other extensive forms of recreation.

BROUSE ASSOCIATION (BE)

Brouse soils are found mainly in the New Denver, Galena Bay and Summit Lake areas. They also occur as a narrow band in the Duncan River drainage basin. The parent material consists of a shallow mantle (generally less than 5 ft. thick) of mixed colluvium and glacial till overlying fine-grained bedrock (slate, shale and some andesitic volcanic rocks). The underlying bedrock is soft and in places partially weathered.

The soils occupy the steep, forested, upper mountain slopes at elevations between 4500 and 5800 feet. Textures are typically gravelly sandy loam or gravelly loam.

Soil development is well-drained Orthic or Lithic Humo-Ferric Podzols with significant inclusions of Orthic Ferro-Humic Podzol at upper elevations, and Orthic Dystric Brunisols at lower elevations. Imperfectly drained seepage phases are associated with all soil developments. Soil horizons are often poorly defined, owing to the masking of horizons by the inherent dark colour of the soil parent material.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Brouse	BE1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	r,w	shallow, medium textured colluvium overlying fine-grained bedrock	4500-5800	Subalpine Engelmann spruce - alpine fir
	BE2	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Orthic Ferro-Humic Podzol seepage phases	r,w i			
	BE4	Orthic Humo-Ferric Podzol	r,w	Sombric Humo-Ferric Podzol Lithic Humo-Ferric Podzol seepage phases	mw r,w i			
	BE5	Lithic Humo-Ferric Podzol	r,w	Orthic Humo-Ferric Podzol	w			

Brouse Association (Cont'd)

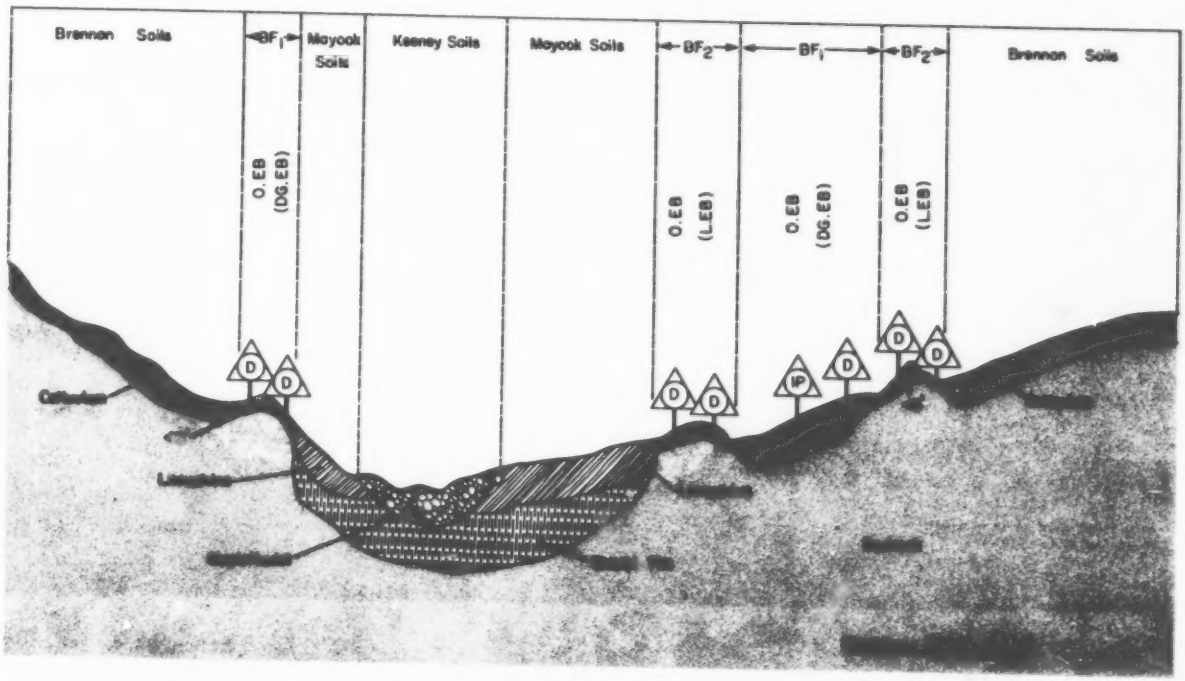
The main trees are Engelmann spruce and alpine fir, with minor amounts of lodgepole pine, alpine larch and mountain hemlock. Significant areas, at lower elevations, support seral trembling aspen and lodgepole pine due to fire history. Short frost-free periods and moderate to high precipitation result in low evaporation rates and low soil-moisture deficiency.

Brouse soils are presently forested and capability Classes for forestry are either 4 or 5. (McCormack, 1968).

BIG FISH ASSOCIATION (BF)

Big Fish soils occur in the eastern part of the map area on rocky ridges in the Rocky Mountain Trench, specifically on the slopes of Steamboat and Jubilee Mountains, and on lower slopes of the Brisco and Vermillion ranges. The elevations range from 3500 to 5000 feet. The soils have developed in a thin mantle of calcareous colluvium overlying the calcareous bedrock, which usually occurs within three to five feet of the surface.

The solum is generally neutral to mildly alkaline, while the C horizon is strongly alkaline. Soil textures throughout the profile are generally loam or sandy loam and contain numerous limestone fragments. Big Fish soils are well drained. Due to the generally dry environment, seepage phases are usually absent. Significant inclusions of Degraded Eutric Brunisols are present throughout the soil landscape and are mapped in conjunction with the dominant Orthic Eutric Brunisols. Inclusions of lithic soils are also present where the depth of soil over bedrock is less than 20 inches.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Big Fish	BF1	Orthic Eutric Brunisol	r,w	Degraded Eutric Brunisol	w	shallow, medium textured colluvium overlying calcareous bedrock	3500-5000	Interior Douglas-fir
	BF2	Orthic Eutric Brunisol	r,w	Lithic Eutric Brunisol	r			

Big Fish Association (Cont'd)

The vegetation is typical of the Interior Douglas-fir forest zone. Douglas-fir is the dominant tree species although lodgepole pine, trembling aspen and, at higher elevations, some Engelmann spruce also are present. Ground vegetation is composed of blue-bunch wheat grass, Idaho fescue and pine grass. The winters are cold with moderate snowfall and polar cold air masses often dominate the winter climate. Typically, the climate of the Big Fish soils is colder in the winter and drier in the summer than soils in the western part of the map area.

Big Fish soil areas are ideally suitable for ungulate (Mountain sheep) winter ranges. Forests and agriculture values are of little importance.

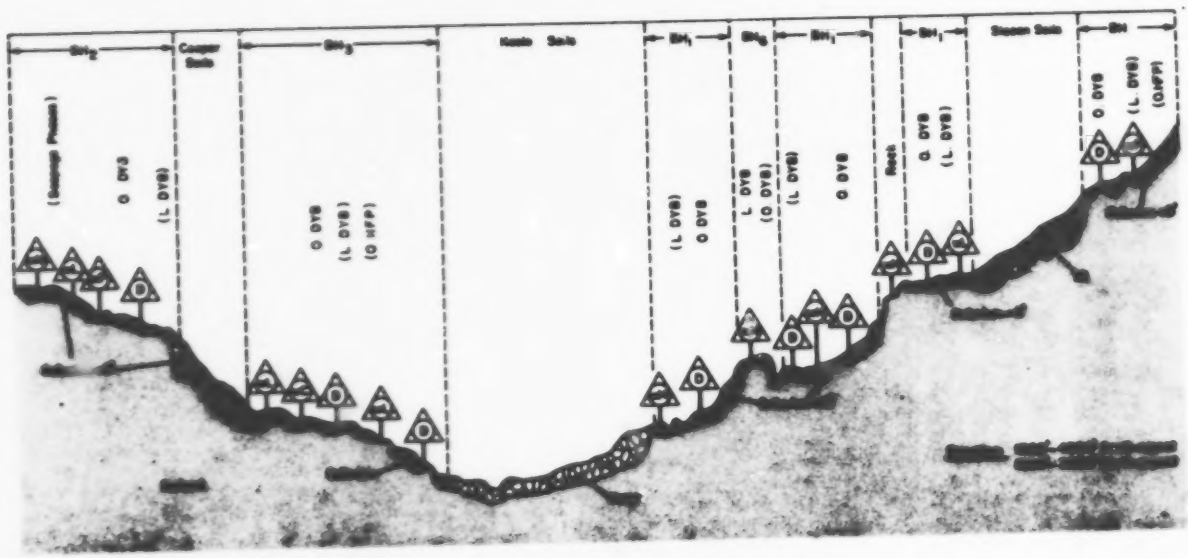
Extensive recreational uses such as hiking and trail riding are also possible.

BUHL CREEK ASSOCIATION (BH)

The Buhl Creek soils occur on steep terrain in the Fry Creek watershed, and in areas east of Kootenay Lake, north of Nakusp to Galena Bay and southeast of Revelstoke. They occupy middle and lower slopes at elevations from approximately 1500 to 3500 or 4000 feet on northeast and southwest facing slopes respectively. The parent material consists of a shallow mantle of colluvium, usually less than five feet thick, overlying acidic (mainly granitic) bedrock. Soil textures are sandy loam or loamy sand containing abundant angular rocks, stones and gravel.

Typical soil developments are Orthic or Lithic Dystric Brunisols, with sola that are moderately acid. Cation exchange capacity and base saturation percentage are moderate. Buhl Creek soils are well to rapidly drained and seepage phases are not common. Significant inclusions of Orthic Humo-Ferric Podzols occur in the map units at the upper elevational limits of the association.

Tree species include western hemlock, western red cedar, some birch and lodgepine pine. Douglas-fir, however, is dominant and usually occupies edaphic sites, especially those which have a warm, southwest exposure. Ground cover often includes pinegrass. Buhl Creek soils generally have long



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Buhl Creek	BH1	Orthic Dystric Brunisol	r,w	Lithic Dystric Brunisol	r,w	shallow, moderately coarse to coarse textured colluvium over coarse-grained acidic bedrock	1500-4000	Interior western hemlock - western red cedar
	BH2	Orthic Dystric Brunisol	r,w,	Lithic Dystric Brunisol seepage phases	r,w i			
	BH3	Orthic Dystric Brunisol	r,w	Orthic Humo-Ferric Podzol Lithic Dystric Brunisol	w,r r,w			
	BH6	Lithic Dystric Brunisol	r,w	Orthic Dystric Brunisol	r,w			

frost-free periods and high growing-degree days, but are droughty throughout most of the growing season.

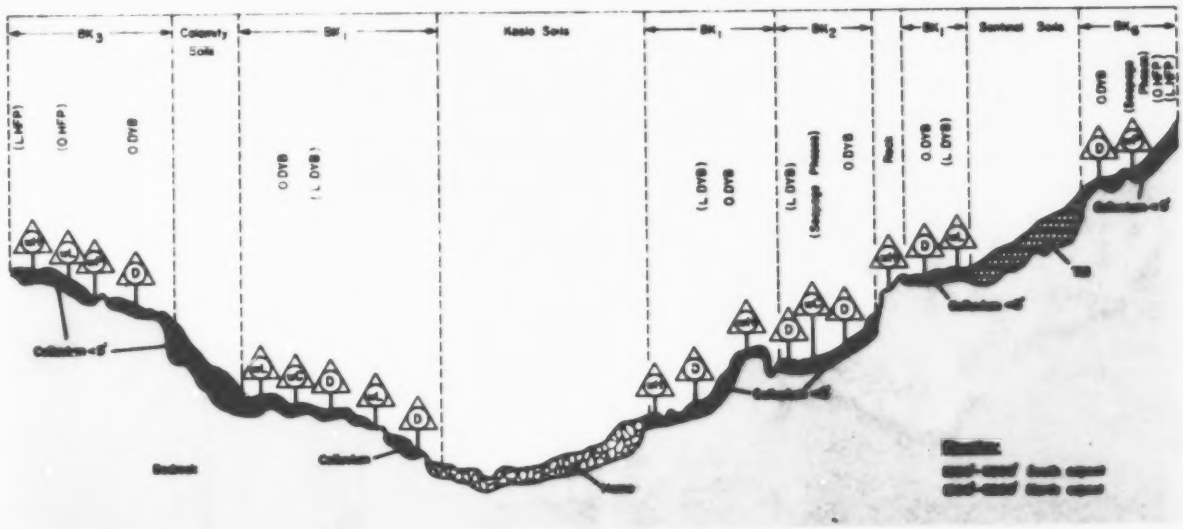
Buhl Creek soils are generally unsuitable for agricultural use, except for some limited domestic grazing. Mean annual increment of wood production commonly varies from 51 to 90 cubic feet per acre per year for Douglas-fir and lodgepole pine. On dryer, exposed slopes with shallow soils this increment is substantially diminished. The main limitations to forest growth are shallowness to rock and soil moisture deficiency. These soils are suitable for ungulate (deer) winter ranges where snowfall is not too deep. Recreational viewing sites are good, and extensive uses such as hiking and trail riding are possible.

BOHAN CREEK ASSOCIATION (BK)

Bohan Creek soils dominate in map units between elevations from 1500 to about 3500 feet northeast and west of Kootenay Lake, and in the vicinity of Duncan Lake, Slocan Lake and Upper Arrow Lake. They occur on the lower, forested, steep slopes of main and side valleys. The parent material consists of a thin mantle (less than 5 ft. thick) of colluvium mixed with some glcial till overlying medium-grained bedrock (argillite, slate, quartzite and schists). Textures generally vary from gravelly sandy loam to gravelly loam.

Bohan Creek Association soil development is typically Orthic or Lithic Dystric Brunisol with inclusions of Orthic Humo-Ferric Podzol at higher elevation. The solum is usually less than 20 inches thick and has a moderate cation exchange capacity due, in part, to a relatively high organic matter content. In some areas where the organic matter accumulation in the surface horizon is substantial, Orthic Sombric Brunisols form significant soil inclusions. Bohan Creek soils are generally well drained, except for a few seepage phases which are imperfectly drained.

These soils are located in the Interior western hemlock-western red cedar forest zone. Western red cedar, western hemlock and lodgepole



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Bohan Creek	BK1	Orthic Dystric Brunisol	r,w	Lithic Dystric Brunisol	r,w	shallow, medium to moderately coarse textured colluvium over medium-grained bedrock	1500-3500	Interior western hemlock - western red cedar
	BK2	Orthic Dystric Brunisol	r,w	Lithic Dystric Brunisol seepage phases	r,w i			
	BK3	Orthic Dystric Brunisol	r,w	Orthic Humo-Ferric Podzol Lithic Humo-Ferric Podzol	w,r r,w			
	BK6	Orthic Dystric Brunisol	r,w	Orthic Humo-Ferric Podzol Lithic subgroups seepage phases	w,r r,mw i			

pine are usually present and Douglas-fir is dominant on exposed ridges and in other edaphic sites. Ground cover is sparse with only a few native grazing species.

The soils are presently forested. Forest growth is moderate to low because of low soil moisture-holding capacity, and shallowness to bedrock. Limited areas are used as winter ranges by deer on the lower slopes near upper Arrow Lake.

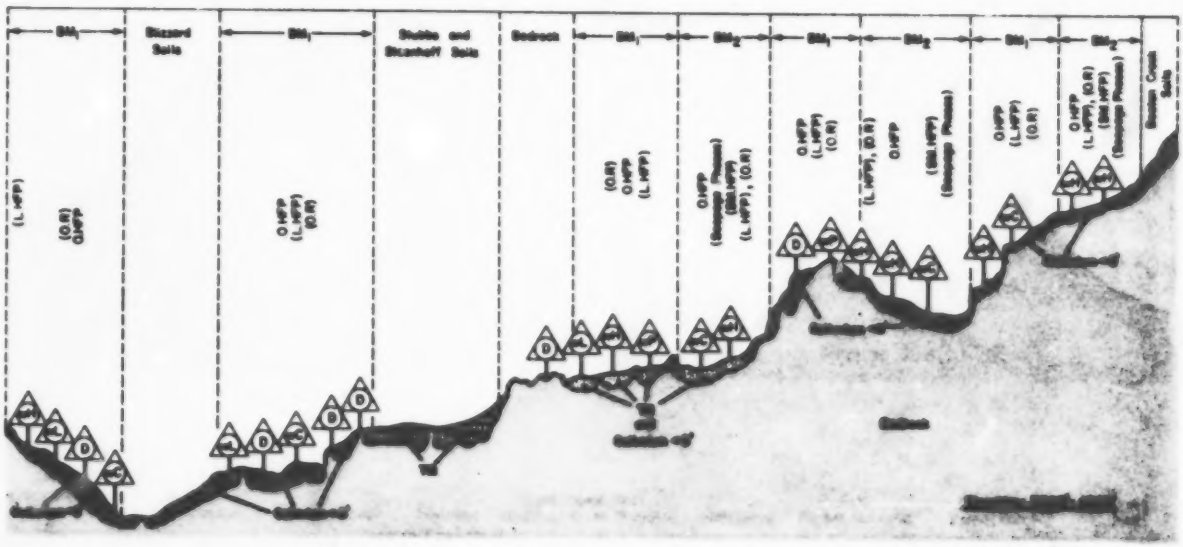
BURKITT ASSOCIATION (BM)

Burkitt soils are mapped in the Galena Bay-Beaton area, Retallack-Sandon-New Denver-Hills area, and in a narrow band near the Duncan River. They have developed from colluvium mixed with some glacial till overlying fine-grained bedrock (slate, shale and phyllite). They occur between elevations of 3500 to about 4800 feet and occupy the mid-positions of steep mountain slopes. The underlying bedrock is often soft and weathered for about five feet. The depth of the gravelly sandy loam to gravelly silt loam textured colluvial material is generally less than five feet.

Typical soil development is Orthic or Lithic Humo-Ferric Podzol. Due to the dark coloured parent material, horizon differentiation in some areas is not evident and here Orthic Regosols form significant soil inclusions. A few small areas with Sombric Humo-Ferric soil development occur near Retallack in a burned area where grasses and trembling aspen establishment has led to the formation of an organic matter rich Ah horizon. Most Burkitt soils are well drained.

Burkitt soils occur in the Interior western hemlock-western red cedar forest zone. The main trees consist of western hemlock, western red cedar, Douglas-fir, lodgepole pine and western larch. Soil moisture during the growing season is usually not limiting. The climate is characterized by a mean annual precipitation of about 25 to 45 inches and mean annual temperature of about 41°F.

Burkitt soils are presently forested. Use by wildlife (deer) is limited to burned areas due to lack of suitable browse and grass species in forested areas.

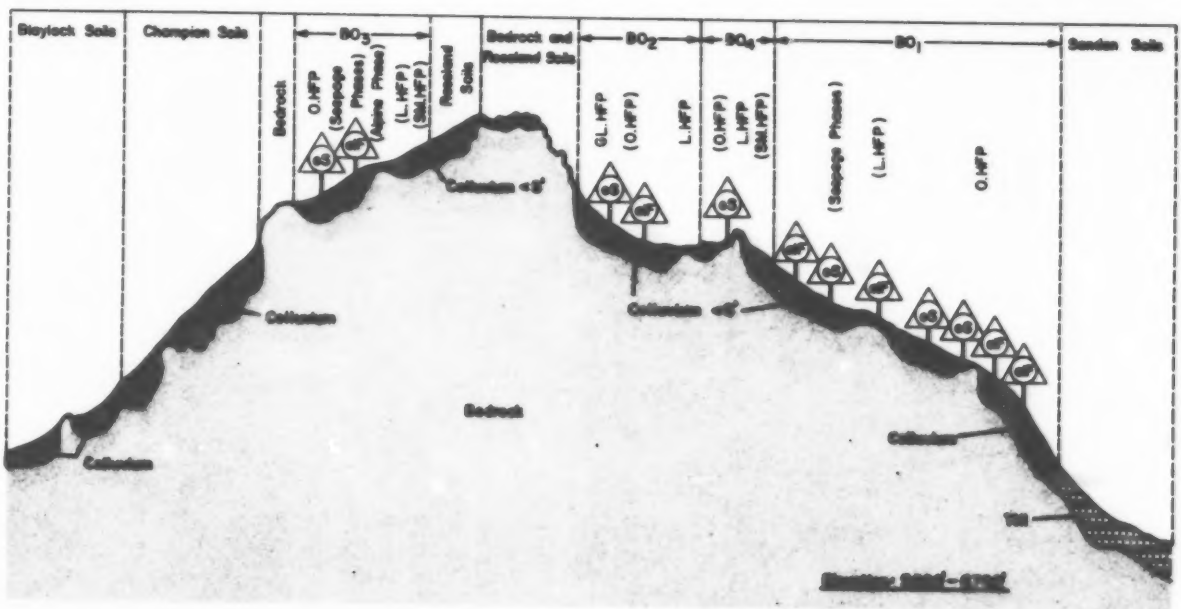


Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Burkitt	BM1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Orthic Regosol	w w	shallow, medium textured colluvium overlying fine-grained bedrock	3500-4800	Interior western hemlock - western red cedar
	BM2	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Orthic Regosol Sombric Humo-Ferric Podzol seepage phases	w w mw i			

BONNER ASSOCIATION (BO)

The Bonner soil association occurs throughout the western part of the map area at elevations varying from 5600 to 6700 feet. The main areas are in the vicinities of Trout Lake, Beaton, and Westfall River. The soil parent material consists of a thin mantle (less than five feet thick) of steeply-sloping colluvium overlying medium-grained (argillic) bedrock. The association occurs on mountain ridges, upper slopes and in cirque depressions. Soil textures generally range from silt loam to gravelly sandy loam.

Most Bonner soils are well drained and have Orthic or Lithic Humo-Ferric Podzol development. The soils are very strongly to strongly acid with corresponding low base saturation. The cation exchange capacity is moderately high because of relatively high organic matter accumulation in the solum. At the upper elevational limits, organic matter accumulation is sufficient for Sombric Humo-Ferric Podzol soils to be developed. Seepage phases are relatively common.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Bonner	BO1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	w,r	shallow, medium to moderately coarse textured colluvium over medium-grained bedrock	5600-6700	Subalpine Engelmann spruce - alpine fir (krummholz)
				seepage phases	i			
	BO2	Gleyed Humo-Ferric Podzol	i	Orthic Humo-Ferric Podzol	w			
				Lithic Humo-Ferric Podzol	w,r			
	BO3	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	w,r			
				Sombric Humo-Ferric Podzol	mw			
				alpine phase				
				seepage phases	i			
	BO4	Lithic Humo-Ferric Podzol	w,r	Orthic Humo-Ferric Podzol	w			
				Sombric Humo-Ferric Podzol	mw			

Bonner Association (Cont'd)

The vegetation is typical of the upper parts of the Subalpine Engelmann spruce-alpine fir forest zone. Tree species include both regular and deformed (krummholz) forms of alpine fir and Engelmann spruce. In sheltered areas, stunted whitebark pine, lodgepole pine, and alpine larch may also occur. A short frost-free period (less 30 days) as well as deep, long lasting snows are typical.

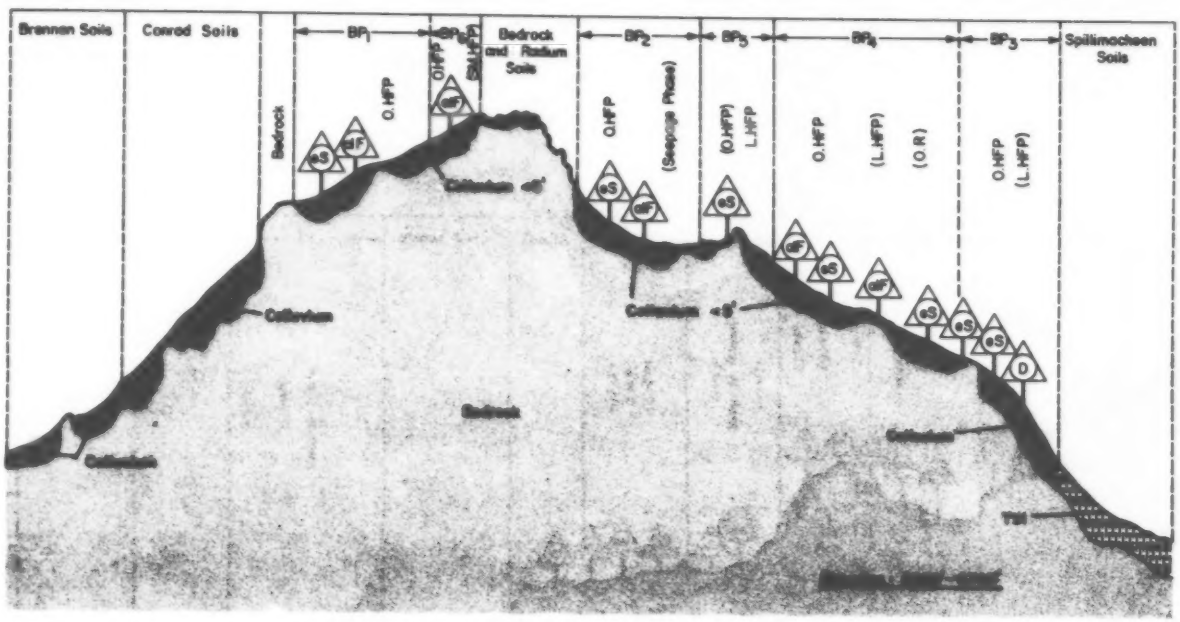
The soils have low capability for forest growth, but have some wildlife grazing potential near tree-line. The potential for extensive recreational persuits such as hiking and horseback riding is excellent.

BUNYON ASSOCIATION (BP)

Bunyon soils are mapped in the northeastern part of the map area at elevations ranging from about 4800 to 6700 feet. They occur in the upper reaches of Toby, Jumbo, Horsethief, Forster, Bugaboo and Vowell creeks on shallow mixed deposits of colluvium and glacial till overlying coarse and medium-grained bedrock. Typically they occupy the generally steep, upper mountain slopes, depressions, ridge tops and ci-que basins. The colluvium, mostly less than five feet thick, is moderately permeable, stony and bouldery. Soil textures vary from gravelly and cobbly sandy loam to silt loam. Bunyon soils are rapidly to well drained. Seepage sites are infrequent.

Soil development is dominantly Orthic or Lithic Humo-Ferric Podzol, the solum depths are relatively shallow, sometimes as thin as 12 inches. The soils are strongly acid and base saturation is low.

The Bunyon soils occur in the Subalpine Engelmann spruce-alpine fir forest zone. The dominant tree species are Engelmann spruce and



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Bunyon	BP1	Orthic Humo-Ferric Podzol	r,w	.....		shallow, moderately coarse to coarse textured colluvium overlying coarse to medium-grained bedrock	4800-6700	Subalpine Engelmann spruce - alpine fir
	BP2	Orthic Humo-Ferric Podzol	r,w	seepage phase	r,w			
	BP3	Orthic Humo-Ferric Podzol	r,w	Lithic Humo-Ferric Podzol	r,w			
	BP4	Orthic Humo-Ferric Podzol	r,w	Lithic Humo-Ferric Podzol Orthic Regosol	r,w w			
	BP5	Lithic Humo-Ferric Podzol	r,w	Orthic Humo-Ferric Podzol	w			
	BP6	Orthic Humo-Ferric Podzol	r,w	Sombric Humo-Ferric Podzol	mw			

alpine fir, with minor amounts of Douglas-fir and lodgepole pine at the lowest elevations. The climate is relatively cool and dry (less than 60 frost-free days and about 15 inches precipitation from May to September).

The soils are presently forested. Land capability classes for forestry range from Class 5 to 6 depending upon aspect, soil depth and presence of seepage.

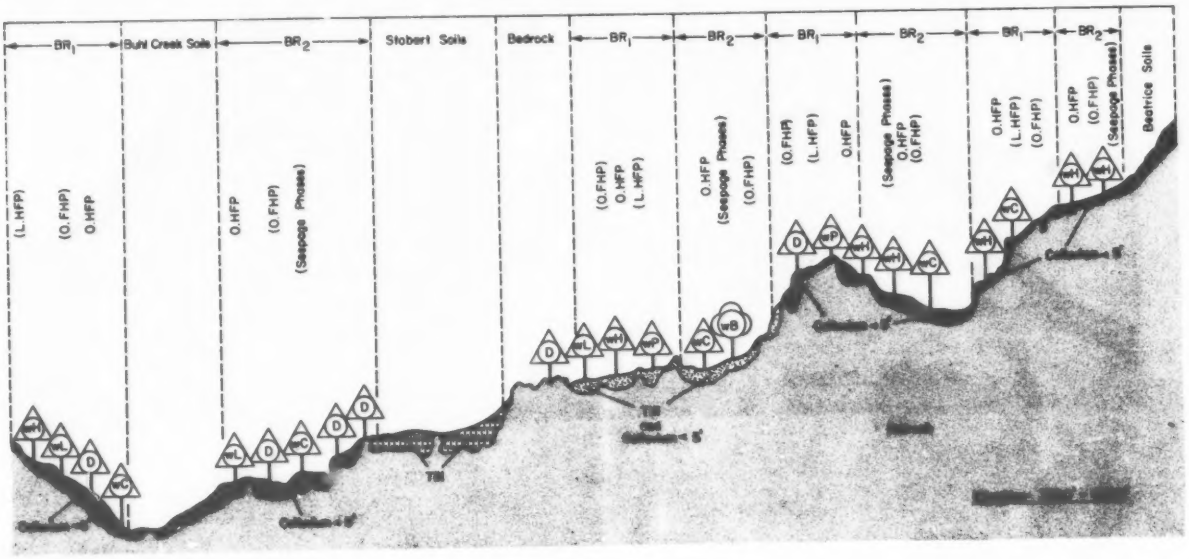
BERGMAN ASSOCIATION (BR)

Bergman soils occur on forested upper mountain slopes east of Kootenay Lake, from Roseberry and Summit Lake to near Trout Lake and east of Upper Arrow Lake at elevations betwen 3500 and 4800 feet. The soil parent material consists of shallow, moderately coarse textured mixed colluvium and glacial till (less than five feet thick) derived from underlying acidic, coarse-grained bedrock (granite, quartzite, granodiorite). The landforms are characterized by moderately sloping middle elevation mountain sides.

Dominant soil development is Orthic Humo-Ferric Podzol. The thickness of the B horizon, often composed of both podzolic Bf and brunisolic Bm horizons, is about 20 inches and is well developed. Near the upper elevations, Orthic Ferro-Humic Podzols as well as seepage phases of the modal soil together with Lithic Humo-Ferric Podzols form significant inclusions.

The soils are permeable, stony, and well to rapidly drained. The typical texture is gravelly sandy loam. Long frost-free periods are usual for these soils and, due to the high snowfall during the winter, they generally do not freeze. Moist, cool conditions are common in the summer. The vegetation is typical of the Interior western hemlock-western red cedar forest zone with western hemlock, western red cedar, occasional Douglas-fir and western larch as the usual tree species.

The soils are presently forested. Forest capability is classes 3 and 4. Rooting depth limited by bedrock, and low water holding capacity are the main soil limitations.



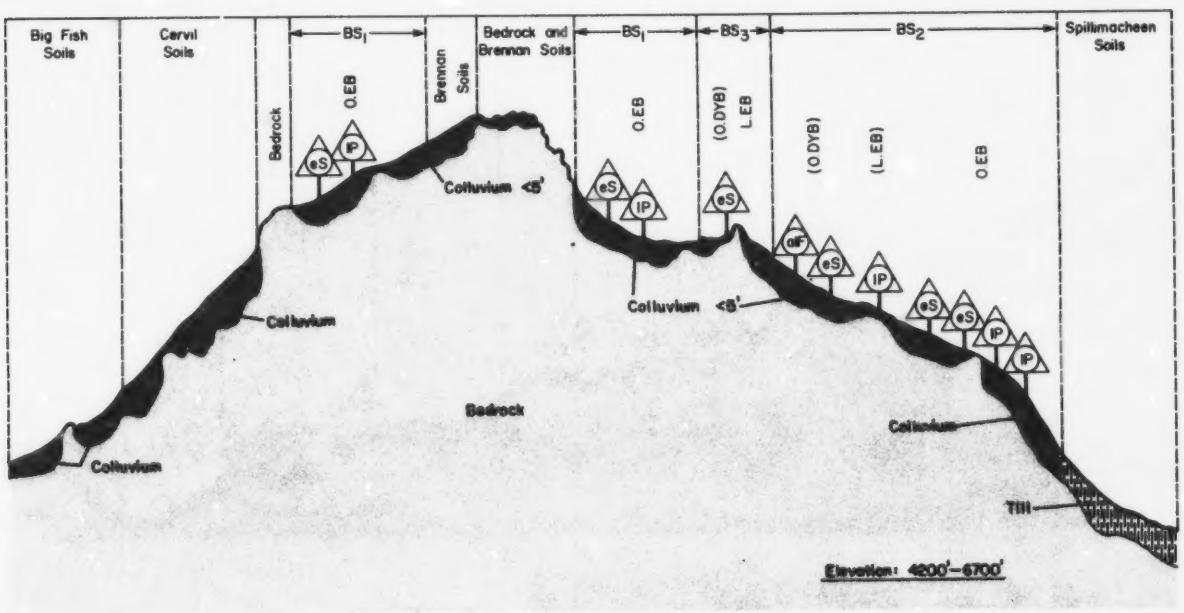
Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Bergman	BR1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Orthic Ferro-Humic Podzol	r,w w	shallow, moderately coarse textured colluvium overlying	3500-4800	Interior western hemlock - western red cedar
	BR2	Orthic Humo-Ferric Podzol	w	Orthic Ferro-Humic Podzol seepage phases	w i	coarse-grained acidic bedrock		

BADSHOT ASSOCIATION (BS)

Badshot soils are widespread throughout the eastern part of the map area at elevations from 4200 to 6700 feet. They occur on forested ridges, on the upper parts of long forested slopes, and in depressional cirque basins. The landforms are usually strongly and steeply sloping. The parent material is strongly calcareous colluvium (less than five feet thick) overlying limestone, dolomite and other calcareous bedrock. The colluvium is moderately permeable, stony, bouldery and loosely compacted. Soil textures usually range from gravelly loam to gravelly silt loam.

Typical soil development is Orthic or Lithic Eutric Brunisol. Soil reaction is slightly acid in the B horizon and moderately alkaline in the C horizon. The base saturation of the B horizon is moderately high. The surface organic litter layer is partially mixed with mineral soil producing thin Ah horizons in some areas. Significant Orthic Dystric Brunisols also occur in higher elevation segments of the landscape.

These well-drained soils are located in the Subalpine Engelmann spruce-alpine fir forest zone. The climate is cool and dry (less than 60 frost-free days and about 15 inches seasonal May-September precipitation). The dominant tree cover



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Badshot	BS1	Orthic Eutric Brunisol	w	.....		shallow, medium textured colluvium overlying calcareous bedrock	4200-6700	Subalpine Engelmann spruce - alpine fir
	BS2	Orthic Eutric Brunisol	w	Orthic Dystric Brunisol	w			
	BS3	Lithic Eutric Brunisol	w	Orthic Dystric Brunisol	w			

is Engelmann spruce although Douglas-fir also occurs at lower elevations and alpine fir at higher elevations.

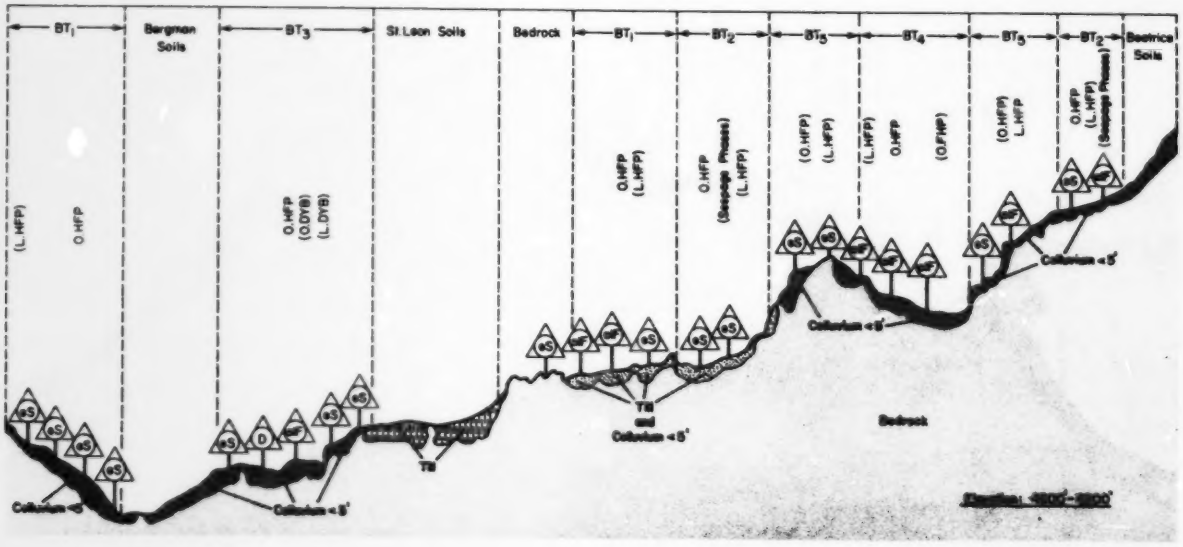
Badshot soils have relatively poor forest growth producing mean annual increments of about 10 to 50 cubic feet per acre per year. The main limitations for tree growth are cold temperatures and limited rooting depth due to bedrock.

BLUEJOINT ASSOCIATION (BT)

Bluejoint soils are confined to an area northeast of Nakusp, near Roseberry and Johnson's Landing, at elevations between 4500 and 6200 feet. Soil parent material consists of shallow (less than 5 ft. thick) colluvium mixed with glacial till and overlies coarse-grained bedrock such as granite, granodiorite and quartz syenite. Landforms include steep, upper mountain slopes, ridgecrests and depressional cirque basins. Gravelly sandy loam is the usual soil texture.

Typically, Orthic or Lithic Humo-Ferric Podzols are the main soil developments. The soils are very strongly acid and have very low base saturation although cation exchange capacities are moderate. Significant soil inclusions of Orthic and Lithic Ferro-Humic Podzols occur at higher elevations, while at the lower elevations significant inclusions are Orthic or Lithic Dystric Brunisols. The Bluejoint soils are mainly well drained. Most lithic areas are rapidly to well drained due to the porous nature and coarse texture of the soils and their topographically "shedding" positions. Seepage phases are imperfectly drained.

The main vegetation is Engelmann spruce and alpine fir, but some lodgepole pine, alpine larch and mountain hemlock may also be present. The



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Bluejoint	BT1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	r,w	shallow, moderately coarse textured colluvium overlying coarse-grained acidic bedrock	4500-6200	Subalpine Engelmann spruce - alpine fir
	BT2	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol seepage phases	r,w i			
	BT3	Orthic Humo-Ferric Podzol	w	Orthic Dystric Brunisol Lithic Dystric Brunisol	r,w r,w			
	BT4	Orthic Humo-Ferric Podzol	w	Orthic Ferro-Humic Podzol Lithic Humo-Ferric Podzol	i r,w			
	BT5	Lithic Humo-Ferric Podzol	r,w	Orthic Humo-Ferric Podzol	w			

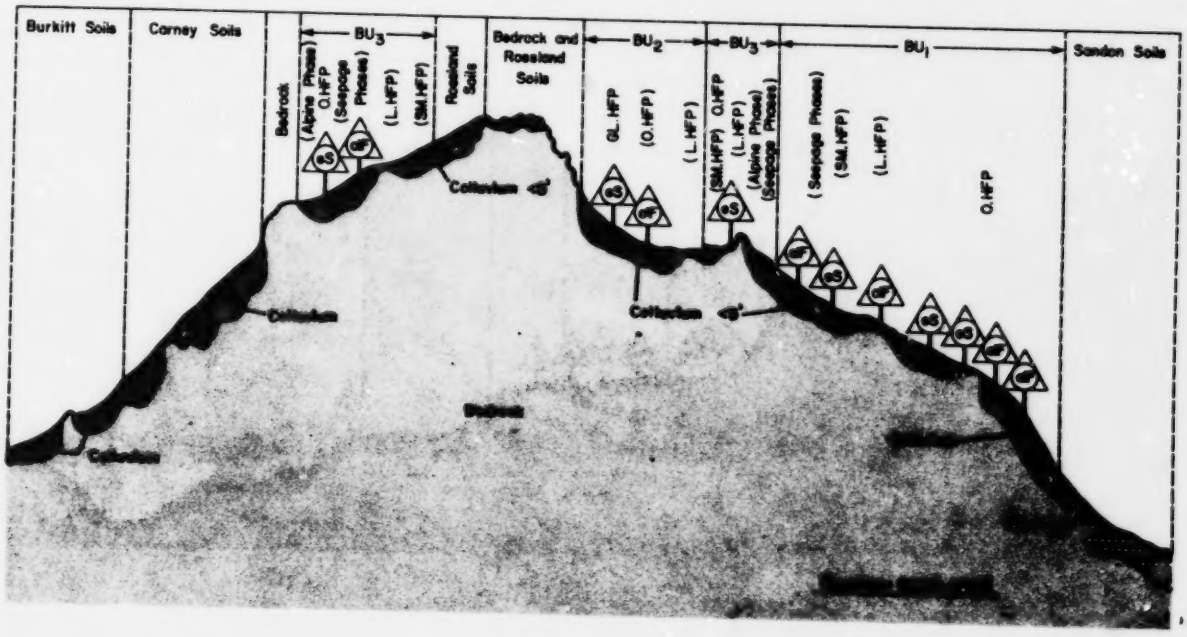
frost-free period is short and mean annual temperatures are low resulting in relatively low evapotranspiration rates. Soil moisture deficiency is low except for soils on southwest aspects. Deep snowfall occurs in winter.

The soils are presently covered by dense stands of Engelmann spruce and alpine fir which provide only limited browsing for wildlife.

BURN CREEK ASSOCIATION (BU)

Burn Creek soils are limited to small areas near New Denver, Retallack, Healy Landing, and north of Duncan Lake. They occur on the upper slopes and tops of ridges and in cirque basins between elevations of 5600 and 6700 feet. The parent material is shallow colluvium or sometimes glacial till (less than five feet thick) overlying fine-grained bedrock (slate, shale, phyllite and micaceous schists) that is often strongly fractured and partially weathered.

The soil textures are generally sandy loam or loam depending on the degree of weathering and the mineral composition of the bedrock. The soils have generally Orthic or Lithic Humo-Ferric Podzol developments. The solum has a moderate exchange capacity but low base saturation. Very strongly acid sola are usual. At the upper limits of the soil association, Sombric Humo-Ferric Podzol and Orthic or Lithic Ferro-Humic Podzols, are the usual soil developments. The increased alpine grass and forb cover in these areas supplies high amounts of organic matter which produces the characteristic Ah and Bhf horizons of these soils. Burn Creek soils



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Burn Creek	BU1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Sombric Humo-Ferric Podzol seepage phases	w,r mw i	shallow, medium textured colluvium over fine-grained bedrock	5600-6700	Subalpine Engelmann spruce - alpine fir (krummholz)
	BU2	Gleyed Humo-Ferric Podzol	i	Orthic Humo-Ferric Podzol Lithic Humo-Ferric Podzol	w w,r			
	BU3	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol Sombric Humo-Ferric Podzol alpine phase seepage phases	w,r mw i			

are generally well drained although seepage areas and depressional positions are imperfectly drained. Lithic areas are usually well to rapidly drained.

Alpine fir, with minor amounts of Engelmann spruce, some mountain hemlock, lodgepole pine, alpine larch and whitebark pine, form the main tree cover. Stunted forms of these trees (krummholz) are prevalent at the higher elevations, especially in exposed locations. The frost-free period is generally less than 30 days.

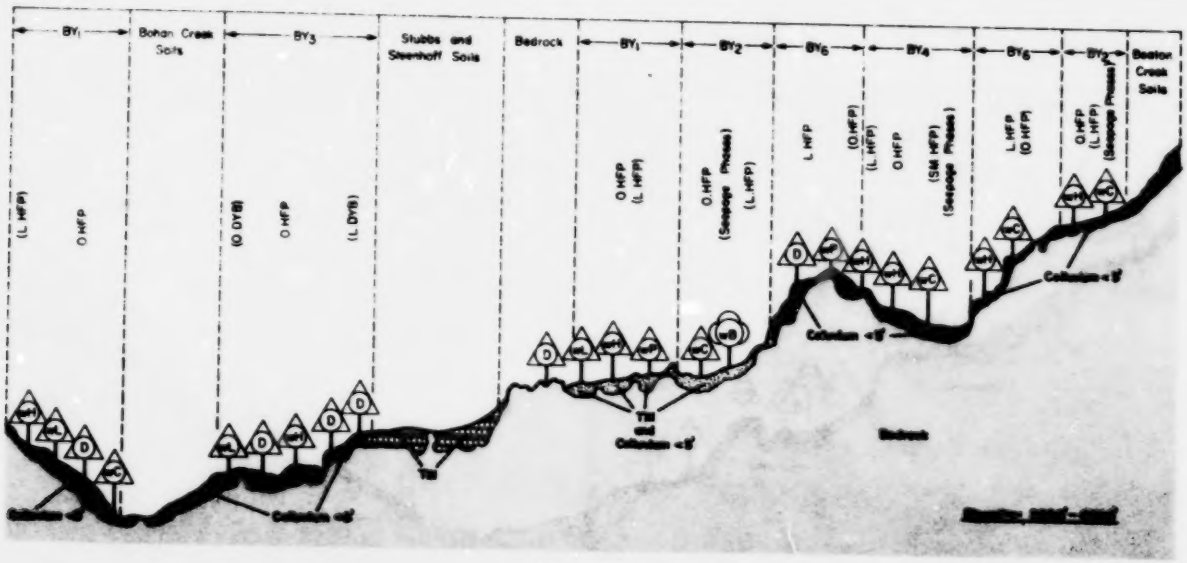
Burn Creek soils are poor for forestry and generally average capability Class 6; cold air temperature and shallowness to bedrock are the main limiting factors. There is considerable recreation potential for hiking, viewing and horseback riding.

BLAYLOCK ASSOCIATION (BY)

Blaylock soils occur throughout the central and western parts of the map area at elevations from approximately 2000 to 4500 feet. The parent material is a shallow mantle (less than 5 ft. thick) of colluvium mixed with glacial till overlying medium-grained, argillaceous and schistose bedrock. Typical landforms are steeply sloping and occur in mid-slope positions in the mountainous landscape. The soil textures are generally gravelly sandy loam and stone content varies from moderate to excessive.

Typical soil development is Orthic or Lithic Humo-Ferric Podzol. Higher elevation areas have significant inclusions of Sombric Humo-Ferric Podzols, while those at lower elevations contain Orthic Dystric Brunisols. The cation exchange capacities are moderately high and base saturation is fairly low. The solum is strongly acid throughout. Blaylock soils are generally well drained, except where local conditions favour impeded drainage or seepage; these are moderately well to imperfectly drained.

The major tree species consist of western



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Blaylock	BY1	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol	r,w	shallow, medium to moderately coarse-textured colluvium overlying medium-grained bedrock	2000-4500	Interior western hemlock - western red cedar
	BY2	Orthic Humo-Ferric Podzol	w	Lithic Humo-Ferric Podzol seepage phases	r,w i			
	BY3	Orthic Humo-Ferric Podzol	w	Orthic Dystric Brunisol Lithic Dystric Brunisol	w r,w			
	BY4	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol Lithic Humo-Ferric Podzol seepage phases	mw r,w i			
	BY6	Lithic Humo-Ferric Podzol	r,w	Orthic Humo-Ferric Podzol	w			

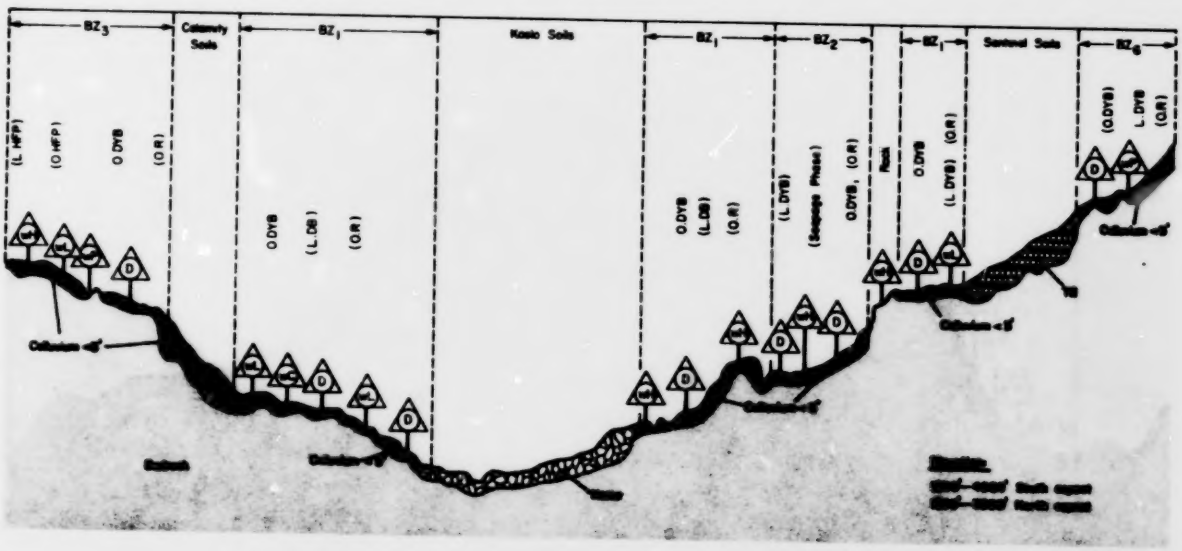
hemlock, western larch and western red cedar, with some lodgepole pine and Douglas-fir. Ground cover is generally sparse and only limited amounts are suitable for grazing.

Due to the steep terrain, these soils have no agricultural potential. They are presently forested with stands of mostly old growth western hemlock. Mean annual increments of 51 to 90 cubic feet per/acre per year for Douglas-fir is the typical forest capability. The main soil limitation is shallowness to bedrock. Due to the dense forest and paucity of browse plants wildlife use is low.

BLIZZARD ASSOCIATION (BZ)

The Blizzard soil association occurs in the Galena Bay-Beaton area, Retallack-Sandon-New Denver-Hills area and in a narrow band trending northwest near the Duncan River. Blizzard soils have developed from a thin (usually less than 5 ft. thick) mantle of colluvium sometimes mixed with glacial till which overlies fine-grained bedrock, such as slate, shale, phyllite, and some andesitic volcanics. Small inclusions of limestone also occur. The soils are present on the lower parts of long mountainous slopes at elevations ranging from about 1500 to 3500 and 4000 feet on northeast and southwest aspects respectively. The underlying bedrock is often soft and weathered.

Soil development is quite variable and depends to some degree on the type of bedrock present. However, most soils have Orthic or Lithic Dystric Brunisol development. Significant included soil developments are Orthic Humo-Ferric Podzols at the upper elevations, and Orthic or Lithic Sombric Brunisols in areas where sufficient grass has established after wild fires to form Ah horizons. Orthic Regosols sometimes occur in areas underlain by dark coloured, weathered, shaly bedrock and are the result of either unstable soil conditions or poor diagnostic soil horizon development. The base saturation and cation exchange capacities are



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Blizzard	BZ1	Orthic Dystric Brunisol	w	Lithic Dystric Brunisol Orthic Regosol	r,w w	shallow, medium textured colluvium overlying fine-grained bedrock	1500-4000	Interior western hemlock - western red cedar
	BZ2	Orthic Dystric Brunisol	w	Lithic Dystric Brunisol Orthic Regosol seepage phases	r,w w i			
	BZ3	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol Lithic Humo-Ferric Podzol Orthic Regosol	w r,w w			
	BZ6	Lithic Dystric Brunisol	r,w	Orthic Dystric Brunisol Orthic Regosol	w w			

generally moderate but vary somewhat with the type of underlying bedrock. Soil profile reactions are generally medium acid. Most Blizzard soils have gravelly sandy loam or gravelly loam textures and are well drained except for a few seepage phases which are imperfectly drained.

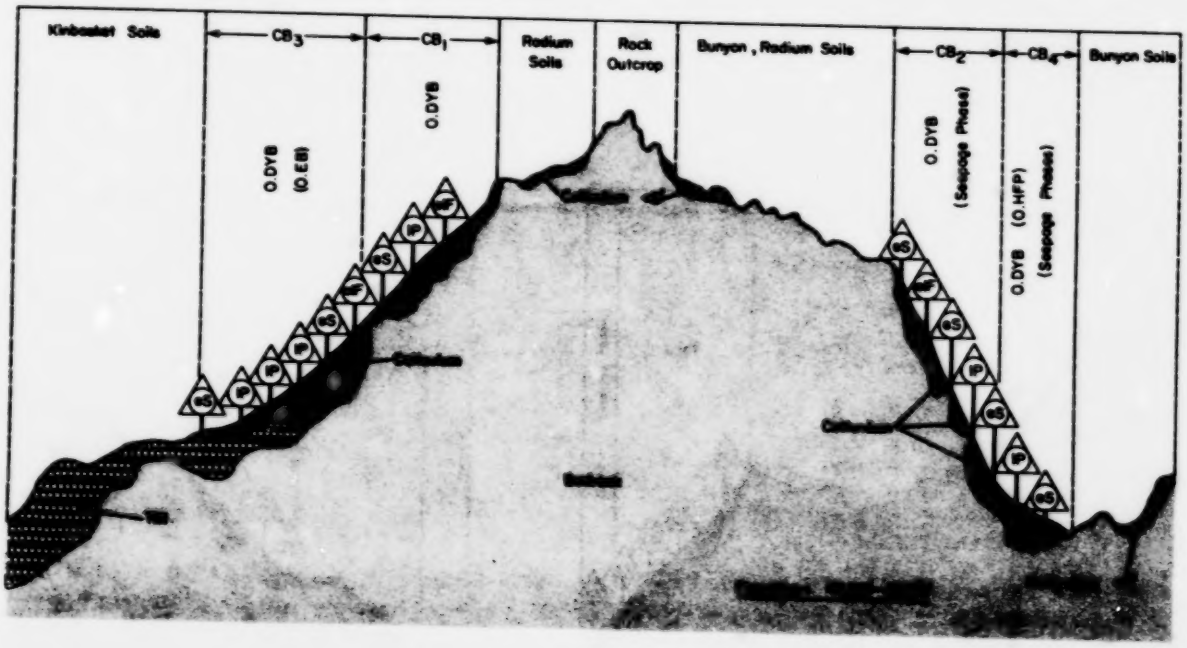
The main tree species is Douglas-fir together with some western hemlock, western red cedar, lodgepole pine, and western larch. Blizzard soils have fairly long frost-free periods and a high number of growing degree days, but tend to dry rapidly due to their rather low water holding capacities and high evapotranspiration rates. Soil moisture deficiencies occur throughout most of the summer, especially on steep southwestern exposures. Some native grasses occur on the forest floor.

The Blizzard soils are presently covered with moderately dense forest. Land capability for forestry is Class 4; soil moisture deficiency and shallowness of soil are the main limitations. Ungulates make limited use of these soils for winter range in areas where snowfall is not too deep.

COUBREY ASSOCIATION (CB)

Coubrey soils are dominant in the mountainous area southwest of Invermere. Specifically, they occur mainly in the Findlay, Doctor, and Dutch Creek drainages at elevations ranging from about 4500 to 6500 feet. The soil parent material consists of deep, moderately coarse-textured, loose and permeable colluvial deposits found on the steep valley walls and lower slopes of the hilly and mountainous terrain. At depths greater than five feet, the colluvium may be underlain by glacial till. The colluvium is mainly derived from coarse and medium-grained bedrock, including argillite, conglomerate, and quartzite.

Typical soil development is Orthic Dystric Brunisol. Areas at higher elevations often have Orthic Humo-Ferric Podzol inclusions, due to the generally moister conditions which occur there. Soils associated with small limestone areas as well as some other locations at lower elevations have Orthic Eutric Brunisol soil profiles. The modal Coubrey soils are well drained; but soil inclusions



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Coubrey	CB1	Orthic Dystric Brunisol	w	.....		deep, moderately coarse textured colluvium	4500-6500	Subalpine Engelmann spruce - alpine fir
	CB2	Orthic Dystric Brunisol	w	seepage phase	i			
	CB3	Orthic Dystric Brunisol	w	Orthic Eutric Brunisol	w			
	CB4	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol seepage phases	w i			

present in depressional and seepage areas are imperfectly drained. The usual soil textures are gravelly sandy loam or gravelly loam.

Coubrey soils have developed under cool and moderately dry climatic conditions (less than 60 frost-free days and less than 25 inches annual precipitation of which 40 to 50% falls as snow). The main trees are Engelmann spruce and alpine fir, with minor amounts of lodgepole pine and Douglas-fir also present at lower elevations. Variable amounts of pinegrass form part of the ground cover in some areas.

Land capabilities for forestry range from Class 3 to 5. Cold temperatures and some soil moisture deficiencies during the growing season are the main limitations. Coubrey soils are unsuitable for cultivated agriculture, but some natural grazing is possible on the more open, exposed slopes which support pinegrass.

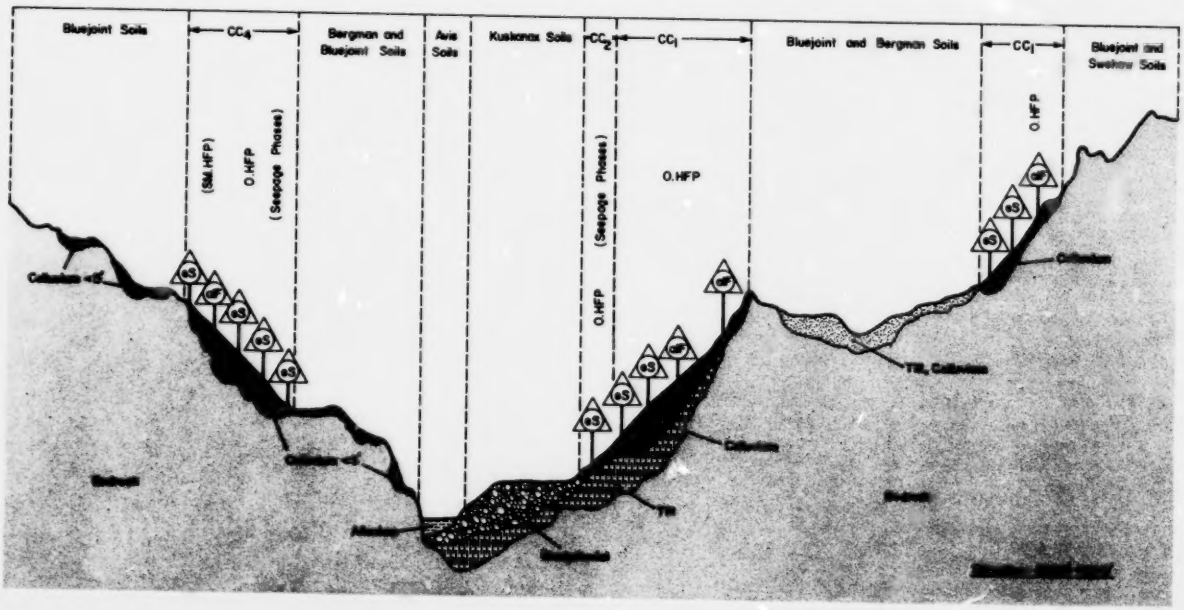
COPPERCROWN ASSOCIATION (CC)

The Coppercrown association occurs in the southwestern part of the map area, mainly north of Nakusp and east of Kootenay Lake. Coppercrown soils have developed on very steeply sloping mantles of deep colluvium derived from coarse-grained bedrock. The colluvium is moderately coarse-textured, permeable, loose and stony. In some areas it may be underlain by glaical till at depths. The usual landforms are steep valley walls and lower slopes in the hilly and mountainous topography. Elevations range from about 4500 to 5800 feet.

The modal soil development is Orthic Humo-Ferric Podzol. The solum is moderately deep, is very strongly acid and has a low cation exchange capacity. Significant Sombric Humo-Ferric Podzol inclusions are found at higher elevations due mainly to the increase in organic matter accumulation in or near seepage areas. Coppercrown soils are well drained except for seepage sites, which have imperfect drainage. The usual soil texture is gravelly sandy loam although gravelly loamy sand also occurs.

Typical trees present are Engelmann spruce and alpine fir with minor amounts of mountain hemlock. Seasonal (May to September) precipitation is about 18 inches and the frost-free period is less than 90 days.

These soils are unsuitable for agriculture due to adverse climate and topography. Moderate capabilities for forestry exist, ranging from Class 3 to Class 4 for alpine fir and Engelmann spruce.

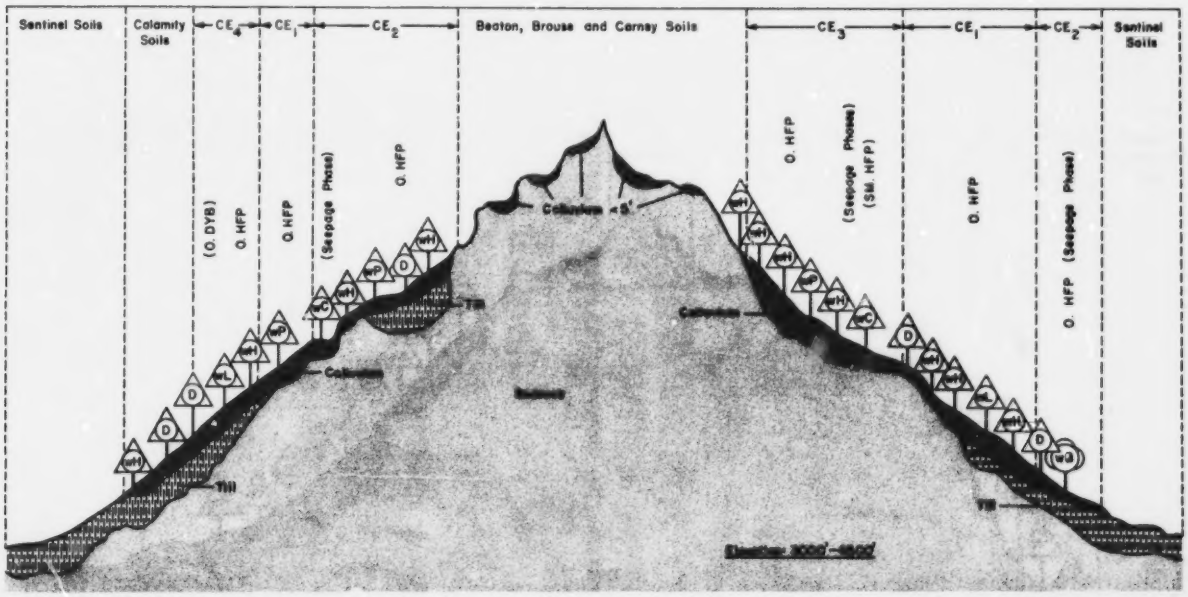


Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Coppercrown	CC1	Orthic Humo-Ferric Podzol	w	.....		deep, moderately coarse to coarse textured colluvium	4500-5800	Subalpine Engelmann spruce - alpine fir
	CC2	Orthic Humo-Ferric Podzol	w	seepage phase	i			
	CC4	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i			

CATARACT ASSOCIATION (CE)

The Cataract soil association occurs throughout the western half of the map area at elevations ranging from about 3000 to 4500 feet. The parent material is medium to moderately coarse textured, loose, permeable colluvium. The deposits are generally deeper than five feet and occur on the middle and lower slopes of the hilly and mountainous terrain. Textures of the solum are generally gravelly loam or gravelly silt loam while the underlying parent material ranges from gravelly sandy loam to gravelly loam. Cataract soils are usually well drained; a few coarser textured areas are well to rapidly drained.

Typical modal soil development is Orthic Humo-Ferric Podzol. The B horizons are deep and well developed and are medium to slightly acid. Seepage phases are numerous in most mapping units and often support a lush ground vegetation that imparts high amounts of organic matter to the soil. In these areas, Sombric Humo-Ferric Podzols are prevalent. At lower elevations, the Cataract soil association includes significant Orthic Dystric Brunisol soils similar to those of the Calamity association.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Cataract	CE1	Orthic Humo-Ferric Podzol	w,r	.....		deep, medium to moderately coarse textured colluvium	3000-4500	Interior western hemlock - western red cedar
	CE2	Orthic Humo-Ferric Podzol	w,r	seepage phase	i			
	CE3	Orthic Humo-Ferric Podzol	w,r	Sombric Humo-Ferric Podzol seepage phases	mw i			
	CE4	Orthic Humo-Ferric Podzol	w,r	Orthic Dystric Brunisol	w,r			

Cataract Association (Cont'd)

The main tree species present on the Cataract soil association are mature and overmature western hemlock and western red cedar. Douglas-fir also occurs in edaphic locations at lower elevations as does Engelmann spruce at higher elevations. Annual precipitation ranges approximately between 45 and 55 inches.

Cataract soils are presently forested and land capability for forestry ranges from Class 1 to Class 3 for Douglas-fir. Due to the steep topography, generally in excess of 30%, only limited logging has taken place.

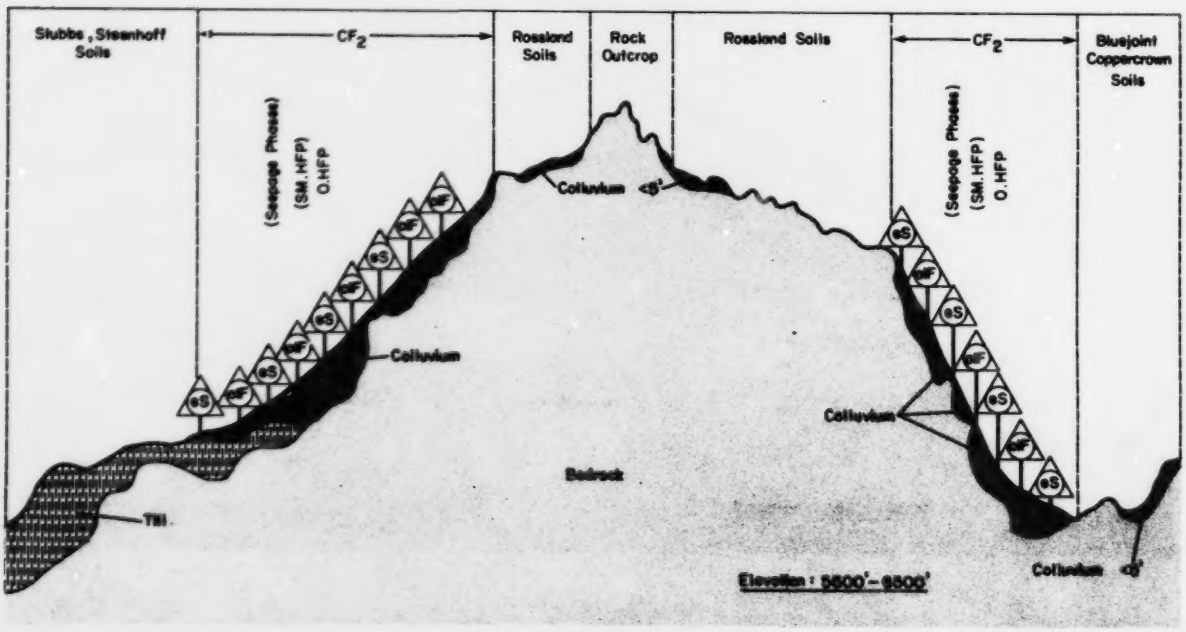
CLIFTY ASSOCIATION (CF)

Small acreages of Clifty soils occur in the upper Fry Creek valley and near Nakusp. The soils have developed from a very steeply sloping mantle of deep colluvial deposits located on valley walls in the hilly and mountainous terrain between elevations of 5500 and 6500 feet. The soil parent material is moderately coarse to coarse textured, stony, loose and permeable. The underlying bedrock is mainly coarse-grained igneous rock such as granite and quartz diorite.

Modal soil development is Orthic Humo-Ferric Podzol. Generally the solum is very strongly acid and has a low base saturation and moderately low exchange capacity. Seepage phases and Sombric Humo-Ferric Podzols are present also, especially near treeline. The usual soil textures are gravelly sandy loam or gravelly loamy sand.

These high elevation, coarse-textured soils are found in a cool and moist climate (precipitation from May to September is less than 20 inches and frost-free period up to 30 days).

Typical trees consist mainly of regular and stunted (krummholz) alpine fir and Engelmann spruce. Land capability for forestry ranges from Class 5 to Class 7; the main limitations are a short growing season and cold temperatures.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Clifty	CF2	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i	deep, moderately coarse to coarse textured colluvium	5500-6500	Subalpine Engelmann spruce - alpine fir (krummholz)

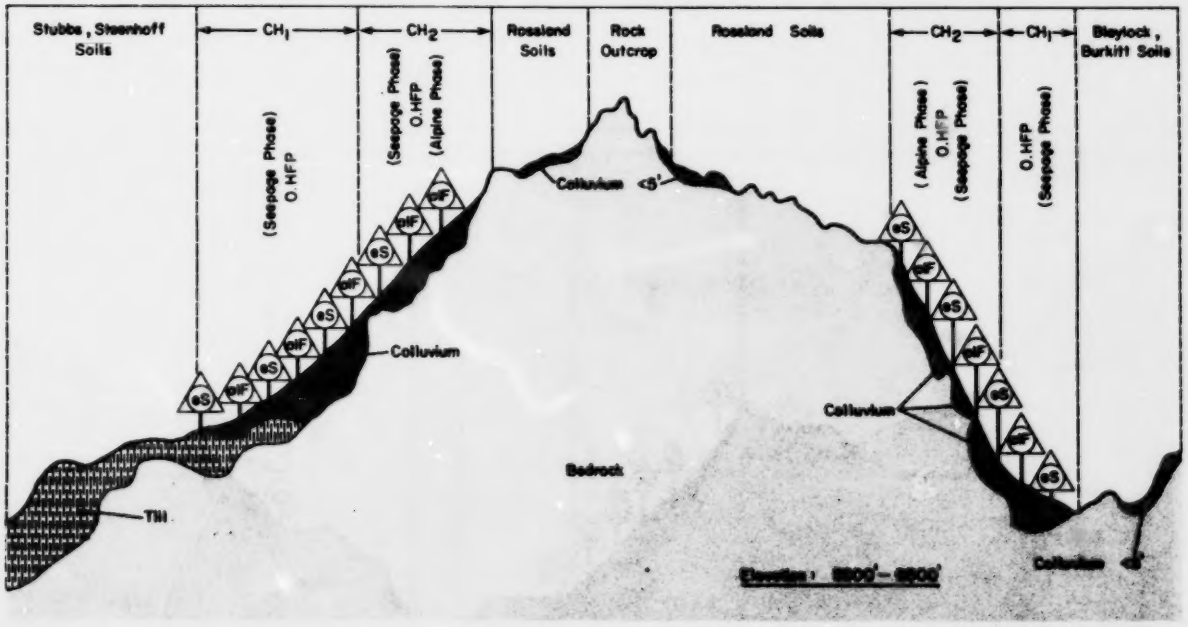
CHAMPION ASSOCIATION (CH)

Minor areas of Champion soils are mapped east of Meadow Creek and south of Nakusp at elevations between 5500 and 6500 feet. The soils have developed from very steeply sloping mantles of deep colluvial deposits on the valley walls of the hilly and mountainous terrain. The soil parent material is medium textured, stony and permeable. The associated bedrock is mainly medium and fine-grained rock such as argillite, andesite, shale and shist. Usual soil textures are gravelly loam or gravelly silt loam.

Soil development is mostly well drained Orthic Humo-Ferric Podzol although significant inclusions of seepage phases also occur.

These podzol soils have developed in a cool and moist environment. The dominant trees are alpine fir and Engelmann spruce in both regular and stunted (krummholz) forms.

The soils are non-arable and the land capability for forestry ranges from Class 3 to Class 5 depending upon aspect, elevation, moisture status and seepage. The main limitation is cold temperature.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Champion	CH1	Orthic Humo-Ferric Podzol	w	seepage phase	i	deep, medium textured colluvium	5500-6500	Subalpine Engelmann spruce - alpine fir (krummholz)
	CH2	Orthic Humo-Ferric Podzol	w	seepage phase alpine phase	i			

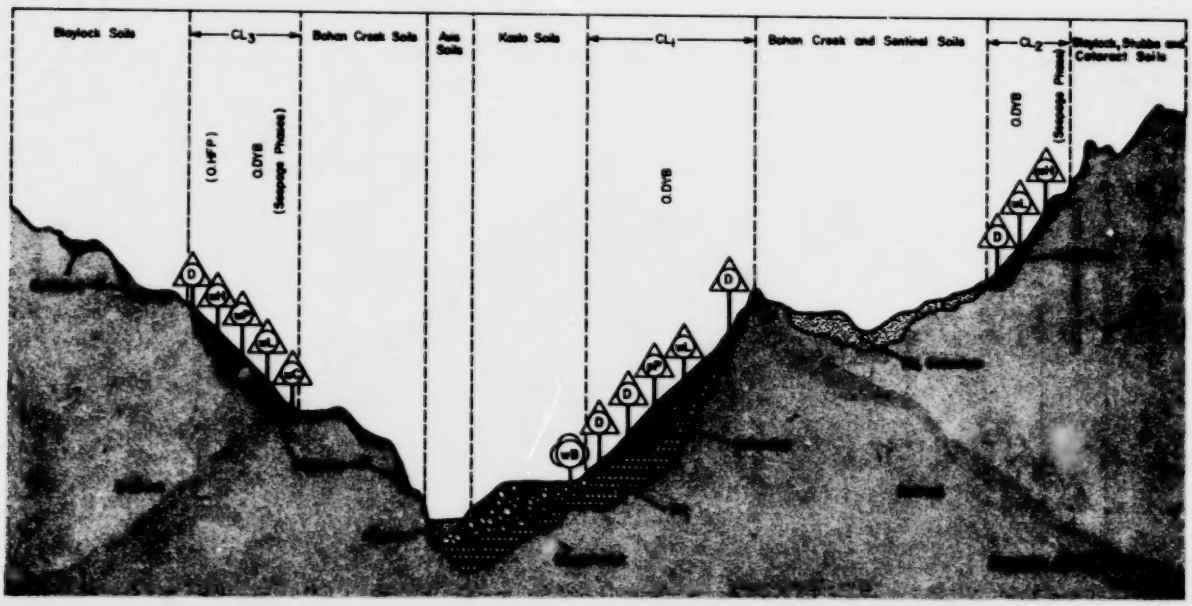
CALAMITY ASSOCIATION (CL)

Calamity soils are found in the south-central part of the map area at elevations between 1500 and 4000 feet. Specifically they occur near Lardeau, Meadow Creek and on the valley slopes bordering Kootenay Lake and the Lardeau River. Calamity soils have developed from deep, medium textured, colluvial deposits on and at the base of steep slopes. The associated bedrock is medium grained.

Typical soil development is Orthic Dystric Brunisol. The soils have moderate to high base saturation, moderate cation exchange capacity and are strongly to moderately acid in reaction. At the upper elevations significant inclusions of Orthic Humo-Ferric Podzol soils similar to the Cataract association occur. Calamity soils are well to rapidly drained and have textures usually ranging from gravelly loam to gravelly sandy loam.

The vegetation is typical of the lower elevations of the Interior western hemlock - western red cedar forest zone. It consists mostly of western red cedar, western hemlock, Douglas-fir and lodgepole pine. Western white pine and western larch are also present. Climatic summer-moisture deficiencies exist which are accentuated by the relatively low moisture-holding capacity of these soils.

Calamity soils have medium to high capability for forest production with capabilities ranging from 70 to 100 cubic feet per acre per year. The soils have limited browse and grazing potential for wildlife. Steep topography accounts for their unsuitability for agriculture.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Calamity	CL1	Orthic Dystric Brunisol	w,r	.....		deep, medium textured colluvium	1500-4000	Interior western hemlock - western red cedar
	CL2	Orthic Dystric Brunisol	w,r	seepage phase	i			
	CL3	Orthic Dystric Brunisol	w,r	Orthic Humo-Ferric Podzol seepage phases	w,r i			

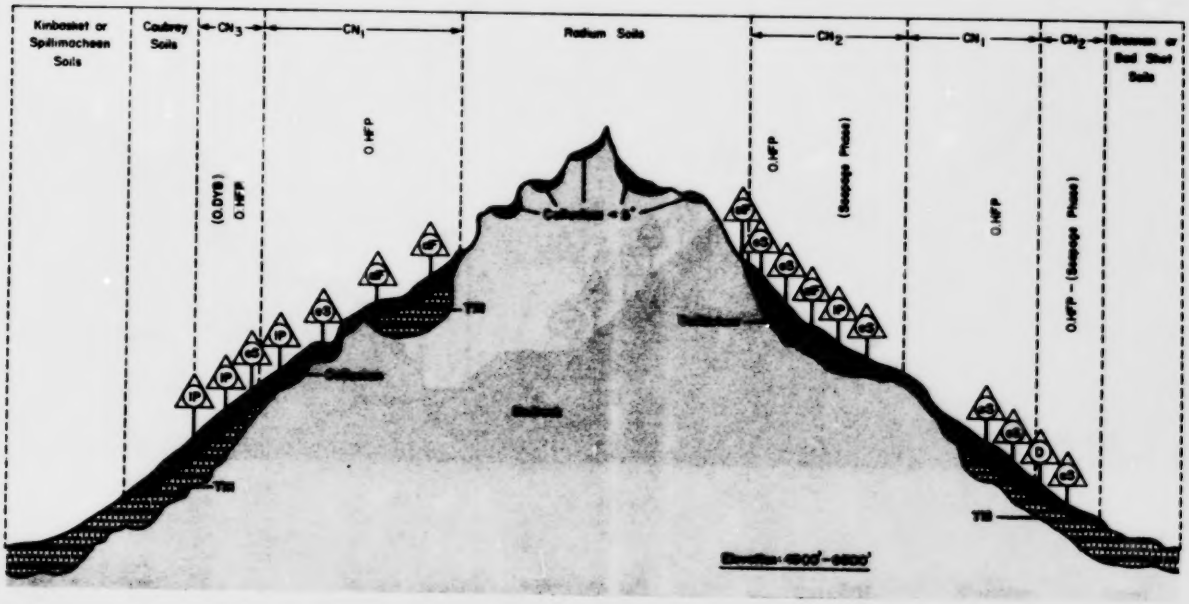
CONRAD ASSOCIATION (CN)

Conrad soils occur only in a few areas in the eastern part of the map area, mainly in the upper valleys of Horsethief, Jumbo, Toby, Bugaboo and Vowell creeks. They have developed on very steeply sloping mantles of deep, medium to coarse textured colluvium derived from a variety of non-calcareous bedrock, which include green slate, argillite, and quartzite. The colluvium occurs on middle and upper valley walls in hilly and mountainous terrain at elevations ranging from 4500 to 6800 feet. At depths greater than five feet, the colluvium is sometimes underlain by pockets of glacial till. Typical soil textures are gravelly sandy loam although variations to gravelly loamy sand or gravelly loam also occur.

Modal soil development is well drained Orthic Humo-Ferric Podzol but at lower elevations, significant inclusions of Orthic Dystric Brunisols are also present. Seepage phases of Conrad soils are relatively limited. The solum is moderately to slightly acid, base saturation is moderate and cation exchange capacity is low.

These soils occur in the Subalpine Engelmann spruce-alpine fir forest zone. The dominant tree species are Engelmann spruce, alpine fir, and lodgepole pine. The climate is cool and relatively dry (less than 60 frost-free days and about 20 inches May to September precipitation).

All of the Conrad soils are presently forested, with forest capabilities ranging from Class 4 to Class 6. Cold temperature is the main growth limitation.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Conrad	CN1	Orthic Humo-Ferric Podzol	w	.....		deep, medium to coarse textured colluvium	4500-6800	Subalpine Engelmann spruce - alpine fir
	CN2	Orthic Humo-Ferric Podzol	w	seepage phase	i			
	CN3	Orthic Humo-Ferric Podzol	w	Orthic Dystric Brunisol	w			

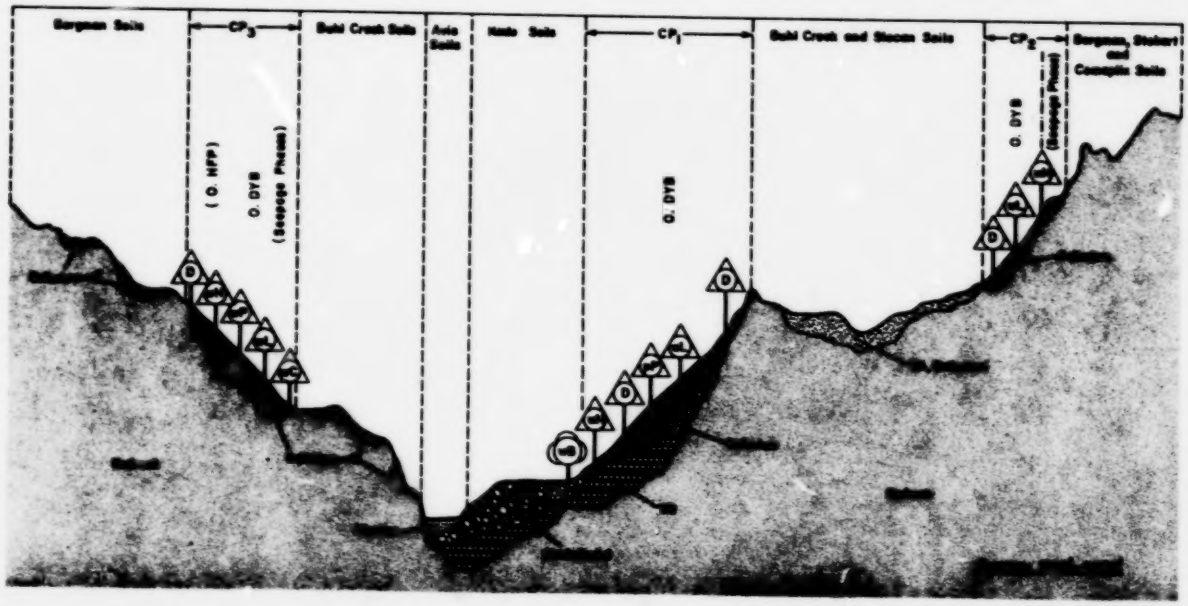
COOPER ASSOCIATION (CP)

Cooper soils occur mainly in the Fry Creek drainage and between Nakusp and Trout Lake. These soils have developed from deep, very steeply sloping mantles of colluvium in hilly and mountainous terrain, at elevations ranging from 1500 to 4000 feet.

The colluvial material is moderately coarse to coarse-textured, loose and permeable. It occurs at the base and on the lower parts of steep slopes. The materials are of variable depth, but generally are more than five feet deep and overlie glacial till or bedrock. The associated bedrock is mainly coarse grained and includes granite, granodiorite, and minor quartzite and quartz syenite. The usual soil textures are stony gravelly sandy loam or stony gravelly loamy sand, and the soils are generally well drained.

The modal soil development is Orthic Dystric Brunisol. The base saturations and cation exchange capacities are moderately low in the strong to medium acid sola. At the higher elevations, where slightly more precipitation and cooler temperatures prevail, Orthic Humo-Ferric Podzol soils form significant inclusions.

The tree species consist of either pure



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Cooper	CP1	Orthic Dystric Brunisol	w	.....		deep, moderately coarse to coarse textured colluvium	1500-4000	Interior western hemlock - western red cedar
	CP2	Orthic Dystric Brunisol	w	seepage phase	i			
	CP3	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol seepage phases	w i			

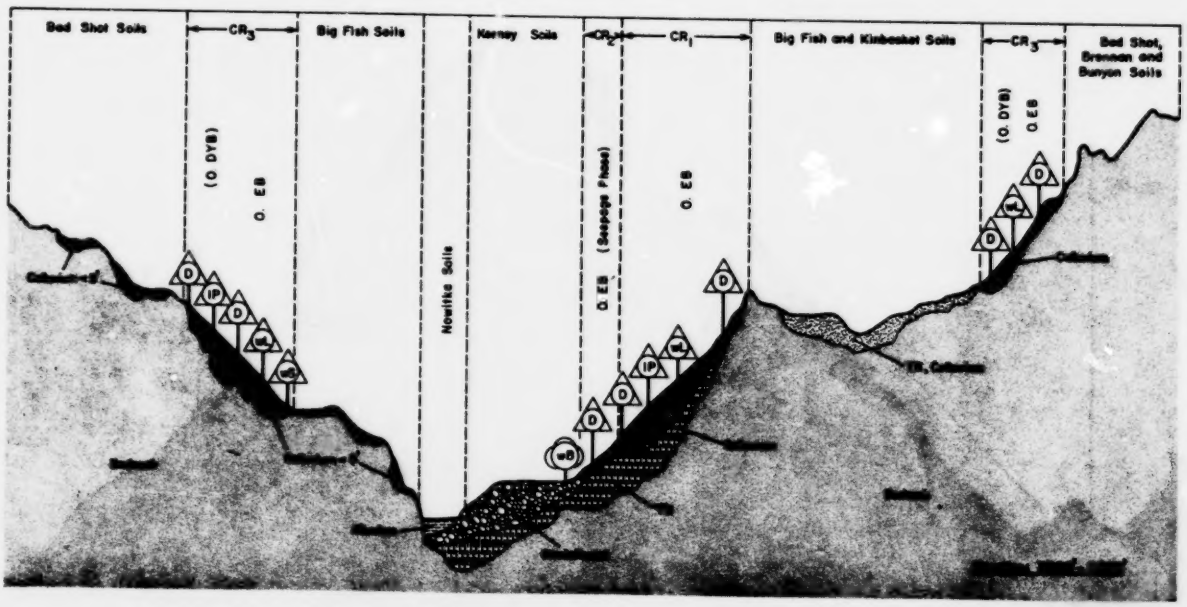
or mixed stands of western hemlock, western red cedar, and western larch. Other tree species sometimes present are Douglas-fir, lodgepole pine and western white pine. The precipitation ranges between 25 and 45 inches per annum. Soil moisture deficits in summer are the result of low soil moisture holding capacities and low amounts of precipitation between June and September.

Medium to high capability for forestry (Classes 3 and 2) is typical of Cooper soils.

CERVIL ASSOCIATION (CR)

Cervil soils occur in fairly limited areas east of the Purcell Divide between elevations ranging from about 3000 to 5000 feet. They have developed on deep, moderately steeply sloping mantles of colluvium in the hilly and mountainous terrain. The soil parent materials are a mixture of deep, medium textured, calcareous colluvium and glacial till, derived from limestone, dolomite and calcareous slate and shale.

Modal soil development is Orthic Eutric Brunisol. Typical soil reactions are mildly to moderately alkaline. The base saturation is high, satisfied mainly by calcium and magnesium ions. Significant soil inclusions are Orthic Dystric Brunisols which are found either at higher elevations where more intensive leaching has taken place, or in areas where the soil parent materials are less calcareous. Soil textures are generally gravelly loam or gravelly silt loam, but range to gravelly sandy loam. Most Cervil soils are well drained, but in places where the parent material is somewhat coarser textured than usual, the soils are rapidly drained. Seepage phases with imperfect drainage do occur but are generally insignificant. Well defined layers of lime accumulation in the upper parent material are often evident.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Cervil	CR1	Orthic Eutric Brunisol	w,r	.....		deep, calcareous medium textured colluvium	3000-5000	Interior Douglas-fir
	CR2	Orthic Eutric Brunisol	w,r	seepage phase	i			
	CR3	Orthic Eutric Brunisol	w,r	Orthic Dystric Brunisol	w,r			

Cervil Association (Cont'd)

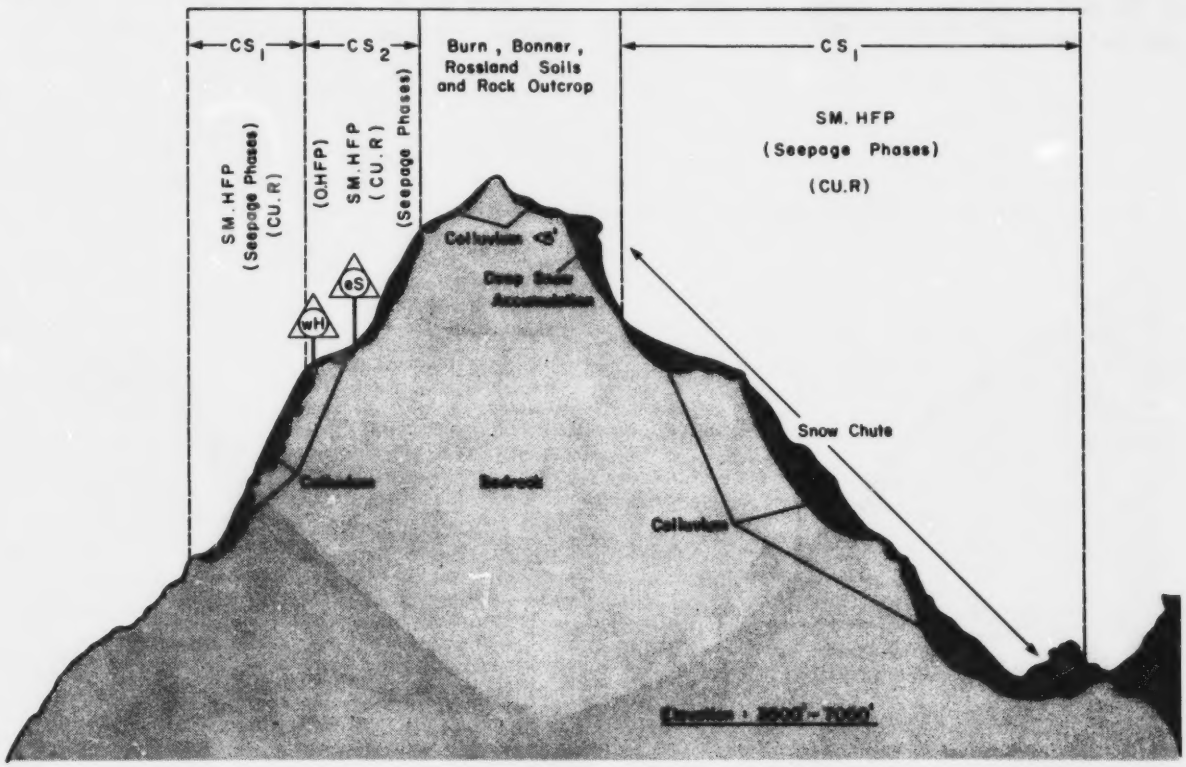
Cervil soils are characterized by generally dry, cool climates (less than 120 frost-free days and 10 to 15 inches average annual precipitation). Douglas-fir is the most common tree, although lodgepole pine and trembling aspen establish as seral species in many areas after wild fires. Ground cover is composed of bluebunch wheat grass, Idaho fescue and pine grass.

Cervil soils are moderately forested at present and have Class 5 to Class 7 capability for forestry; climatic aridity and soil moisture deficiency are the main limitations to growth. The steep topography severely limits their use for agriculture. Many Cervil soil areas, especially those at the lower elevations, provide excellent ungulate winter ranges for deer, elk and bighorn sheep.

MOUNT COND ASSOCIATION (CS)

Mount Cond soils occur throughout the map area west of the Purcell Divide. The major acreages however, are north and northwest of Trout Lake and in the Duncan, Westfall, Incomappleux and Akolkolex River drainages. Elevations range from about 3500 to 7000 feet. Mount Cond soils occur in steeply sloping snowchutes and avalanche tracks where gravity and avalanche activity have deposited colluvium derived mainly from shale, argillite, slate and other medium and fine grained rock. The colluvium is generally medium to moderately coarse textured and although variable, is mostly deeper than 5 feet. Soil texture is predominantly gravelly loam with variable contents of stones and boulders.

Modal soil development is Sombric Humo-Ferric Podzol which is characterized by a deep Ah horizon



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Mount Cond	CS1	Sombric Humo-Ferric Podzol	rw	Cumulic Regosol	w	medium to moderately coarse textured colluvium	3500-7000	Interior western hemlock and subalpine Engelmann spruce - alpine fir
				seepage phases	i			
	CS2	Sombric Humo-Ferric Podzol	rw	Orthic Humo-Ferric Podzol	w			
				Cumulic Regosol	w			
				seepage phases	i			

over podzolic Bf horizons. The deciduous shrub, forb and grass vegetation is responsible for providing the organic matter required for the formation of the Ah horizon. Significant soil inclusions are Cumulic Regosols and Orthic Humo-Ferric Podzols. The former occur in areas where the colluvium is unstable and is actively moving downslope, while the latter are prevalent in stabilized areas no longer actively affected by repeated avalanches. Mount Cond soils generally are moderately well drained, but significant areas are subject to substantial seepage and these have imperfect drainage.

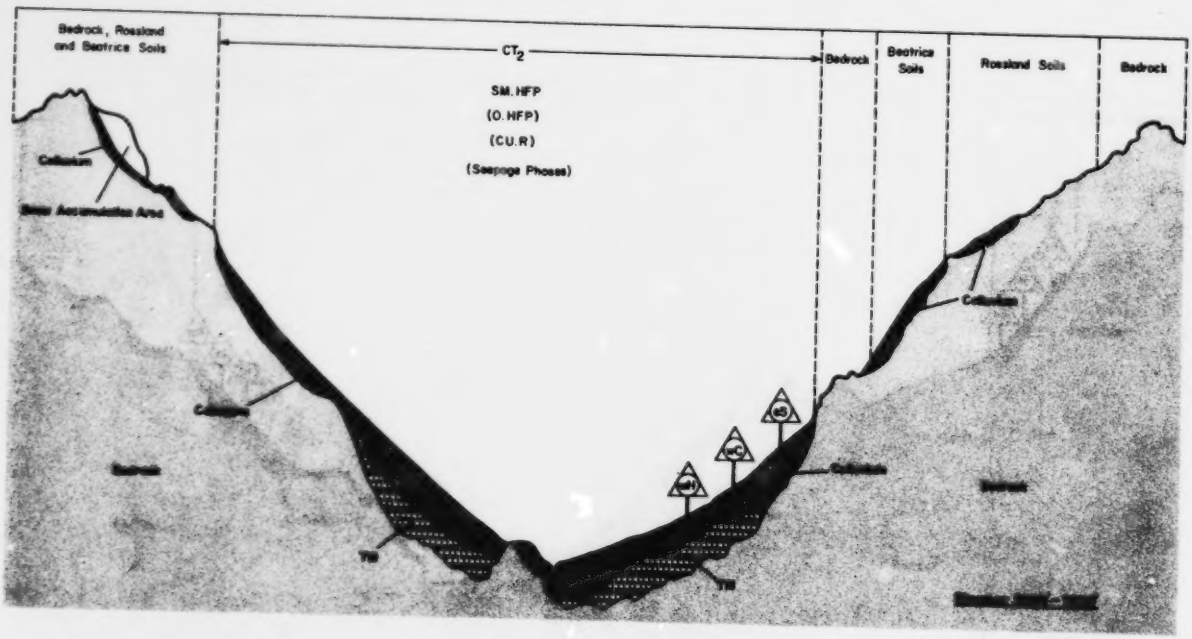
Snowchutes and avalanche tracks can pass through several forest zones. Their size and activity depends on the relief of the terrain, the slope length, steepness and the amount of snow accumulation. Trees do not usually establish in the most unstable and hazardous areas because of frequent snow slides. Generally shrubs and forbs both coniferous and deciduous with minor amounts of grasses form the ground cover.

Mount Cond soils occur in unstable and hazardous areas and are unsuited for most uses. They do however, provide a variety of habitats for wildlife.

CURTIS ASSOCIATION (CT)

Curtis soils occur mainly in the western part of the map area in small pockets at moderately high elevations northeast of Kootenay Lake and between Nakusp and Trout Lake. The soils have developed on very steeply sloping colluvium deposited along snowchutes and avalanche tracks. The material is generally coarse textured, bouldery, loose and permeable. Associated bedrock is usually quartz, granite, or granodiorite. The distribution of materials on the slopes is variable but is usually deeper than 5 feet. Often larger rocks and boulders are located on the lower slope while finer materials are present nearer the apex. Soil textures are usually gravelly sandy loam or gravelly loamy sand.

Soil development is dominantly Sombric Humo-Ferric Podzol. Moderately thick Ah horizons are present in most areas as a result of the dominantly deciduous vegetation. Significant soil inclusions are Orthic Humo-Ferric Podzol, Cumulic Regosol and associated seepage phases. Where some coniferous vegetation has established, the Ah horizons are weak or lacking, and Orthic Humo-Ferric Podzols occur. In areas of active deposition Cumulic Regosols are found. All soils are well to moderately well drained, except for seepage phases which are imperfectly drained.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Curtis	CT2	Sombric Humo-Ferric Podzol	mw	Orthic Humo-Ferric Podzol Cumulic Regosol seepage phases	w w i	deep, moderately coarse textured colluvium	3500-7000	Interior western hemlock and subalpine Engelmann spruce - alpine fir

Snowchutes and avalanche tracks range from the snow accumulation area at about 7000 feet down to about 3500 feet at the valley bottoms, or to where a major slope change occurs. They may travel through several forest zones. Active avalanche areas have no well established vegetation, but older, stabilized tracks may support young stands of Engelmann spruce, alpine fir, western hemlock and western red cedar. Alder, grasses, ferns and other shrubs make up the ground vegetation. The upper elevations are characterized by a short, cool growing season and deep winter snowfalls, with accompanying strong winds and cold soil temperatures.

Due to the instability of the materials and danger of avalanches, the Curtis soils are unsuitable for most uses. They do however, provide a variety of habitats for wildlife.

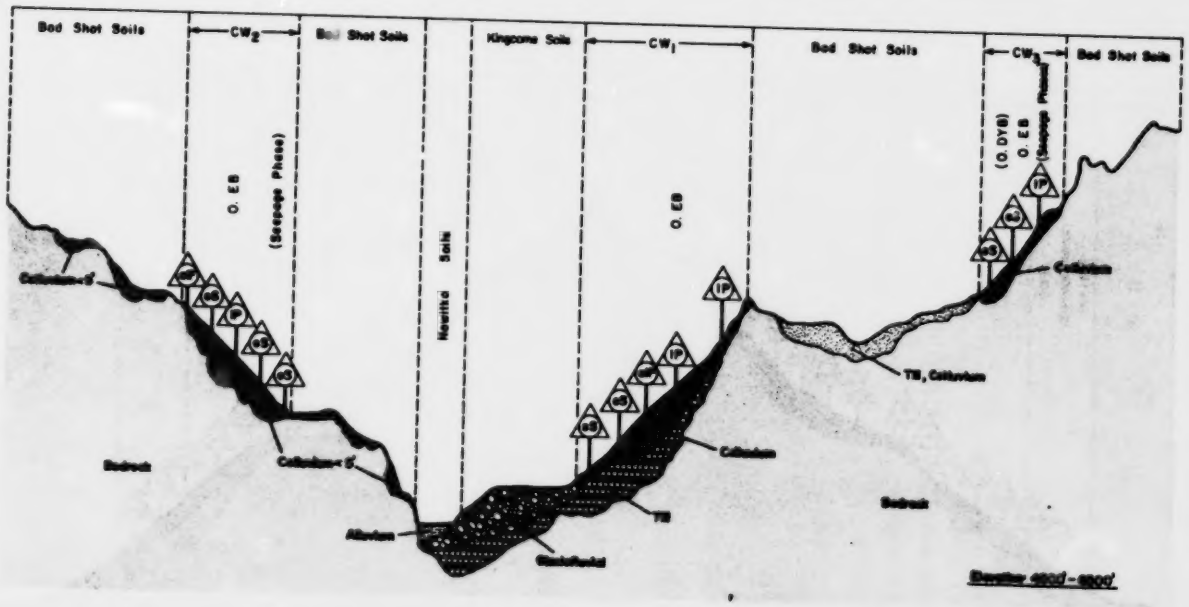
COULDRON ASSOCIATION (CW)

Couldron soils are most common in the eastern part of the map area, mostly east of the Purcell Divide. The soil parent material consists of very steeply sloping, deep, strongly calcareous colluvium derived from limestone, dolomite and other calcareous bedrock. It occurs on the valley walls in hilly and mountainous terrain. Elevations range from 4500 to 6500 feet.

The soil textures mostly range from gravelly loam to silt loam although gravelly sandy loam also occurs. Well-drained Orthic Eutric Brunisols prevail and soil reaction varies from neutral to mildly alkaline. Lime accumulation layers often occur about 18 inches below the soil surface. Significant inclusions of Orthic Dystric Brunisols occur at the higher elevations because of higher leaching and weathering rates. Imperfectly drained seepage phases exist throughout the range of the Couldron association but are most prevalent at the higher elevations.

Tree cover generally consists of Engelmann spruce and alpine fir. Douglas-fir may also be found at lower elevations while lodgepole pine occurs throughout as a seral species after wild fire.

Couldron soils are presently forested and have Class 3 or Class 4 forestry capability. The main limitations for tree growth are cold temperatures, exposure and soil moisture deficiency. Couldron soils are unsuitable for agriculture.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Couldron	CW1	Orthic Eutric Brunisol	w	.....		deep, calcareous, medium textured colluvium	4500-6500	Subalpine Engelmann spruce - alpine fir
	CW2	Orthic Eutric Brunisol	w	seepage phase	i			
	CW3	Orthic Eutric Brunisol	w	Orthic Dystric Brunisol seepage phases	w i			

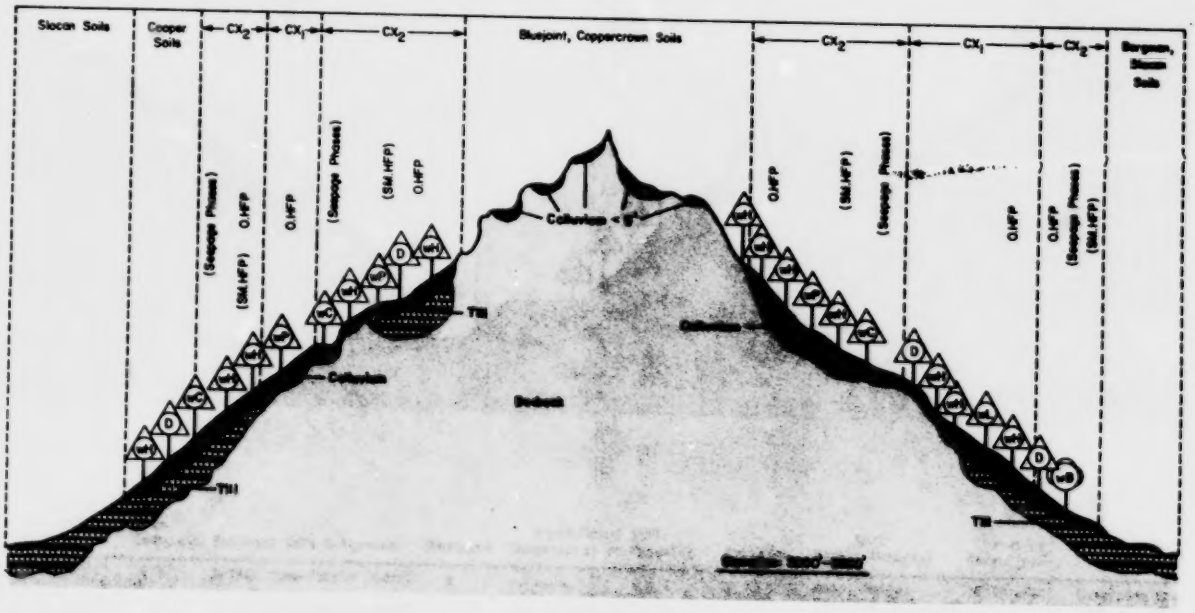
COMAPLIX ASSOCIATION (CX)

Comaplix soils are mapped in the Fry Creek, Kuskanax Creek, St. Leon Creek, and Halfway River watersheds. They have developed from very steeply sloping deposits of deep colluvium on the valley walls in the hilly and mountainous terrain at elevations from 3000 to 5800 feet. The colluvium is moderately coarse to coarse textured, well drained, slightly compacted and permeable. Although the depth of the material varies, it generally is deeper than five feet, and overlies either glaical till or bedrock. The colluvium reflects the composition of the associated bedrock which is generally granite, granodiorite, quartz, and other granitoid rocks.

The modal soil development is Orthic Humo-Ferric Podzol. The soils have strong to medium acid reactions, generally low cation exchange capacities, and moderate base saturation. At the higher elevations, significant inclusions of Sombric Humo-Ferric Podzols occur where dense shrub and forb vegetation exists. Seepage phases are present throughout.

Overmature stands of western hemlock and western red cedar are dominant on Comaplix soils, with the latter being more prevalent in seepage areas. Other tree species are Douglas-fir, western larch and lodgepole pine. A generally cool, moist environment with precipitation between 25 and 45 inches per annum is typical.

Comaplix soils have moderately high capabilities for forest growth and produce from 50 to 90 cubic feet per acre per year of western hemlock.



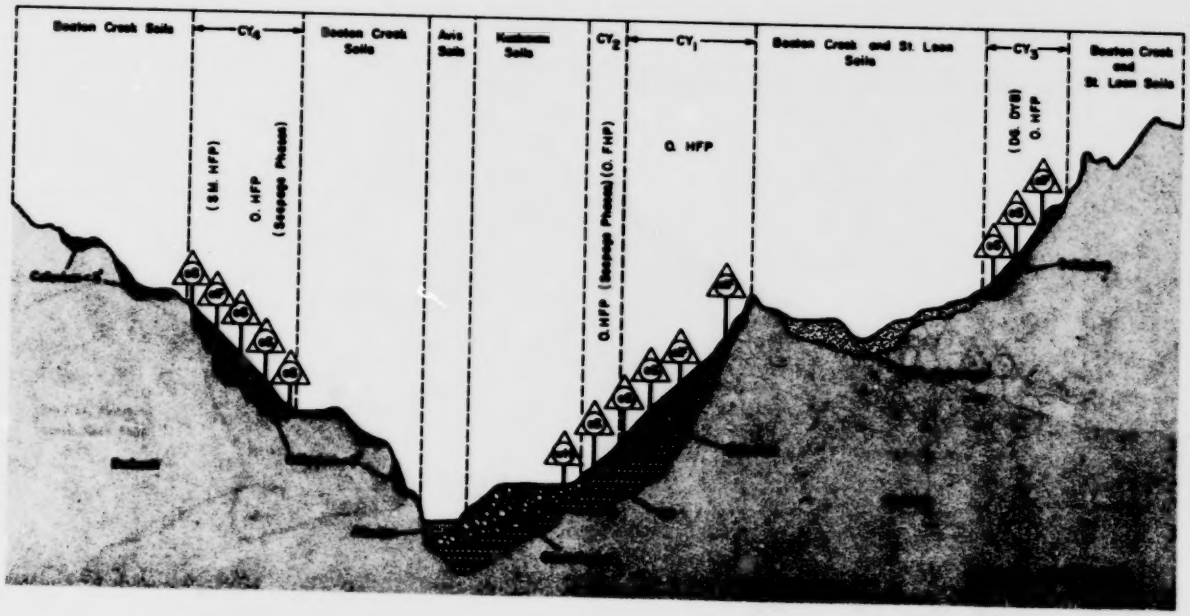
Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Comaplix	CX1	Orthic Humo-Ferric Podzol	w	.....		deep, moderately coarse to coarse textured colluvium	3000-5800	Interior western hemlock - western red cedar
	CX2	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i			

CARNEY ASSOCIATION (CY)

Carney soils are common throughout the western half of the map area at elevations ranging from 4500 to 5800 feet. They have developed from deep, steeply sloping colluvium derived from medium-grained bedrock on the valley walls of the hilly and mountainous topography. The bedrock consists of argillite, argillaceous quartzite, and minor phyllite and slate. The colluvium is loose, permeable, and medium textured. It is generally greater than five feet deep and overlies either glacial till or bedrock.

Typical soil development is Orthic Humo-Ferric Podzol. Significant inclusions are Degraded Dystric Brunisol, Orthic Ferro-Humic Podzol and Sombric Humo-Ferric Podzol. The latter two soils occur in conjunction with either climatically moister areas or seepage sites at the higher elevations.

Soil reaction is very strongly to strongly acid, cation exchange capacites are moderately high and base saturation is medium to low. Carney soils generally are well drained. The usual soil texture is gravelly loam with variations to gravelly sandy



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Carney	CY1	Orthic Humo-Ferric Podzol	w	.....		deep, medium textured colluvium	4500-5800	Subalpine Engelmann spruce - alpine fir
	CY2	Orthic Humo-Ferric Podzol	w	Orthic Ferro-Humic Podzol seepage phases	w i			
	CY3	Orthic Humo-Ferric Podzol	w	Degraded Dystric Brunisol	w			
	CY4	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i			

loam and gravelly silt loam.

Carney soils occur in a cool and moist environment. Seasonal precipitation (May to September) is about 18 inches and total precipitation approaches about 50 inches. The frost-free period is generally less than 90 days. The main trees consist of mature stands of Engelmann spruce and alpine fir. The latter species is more commonly found in pure stands at higher elevations.

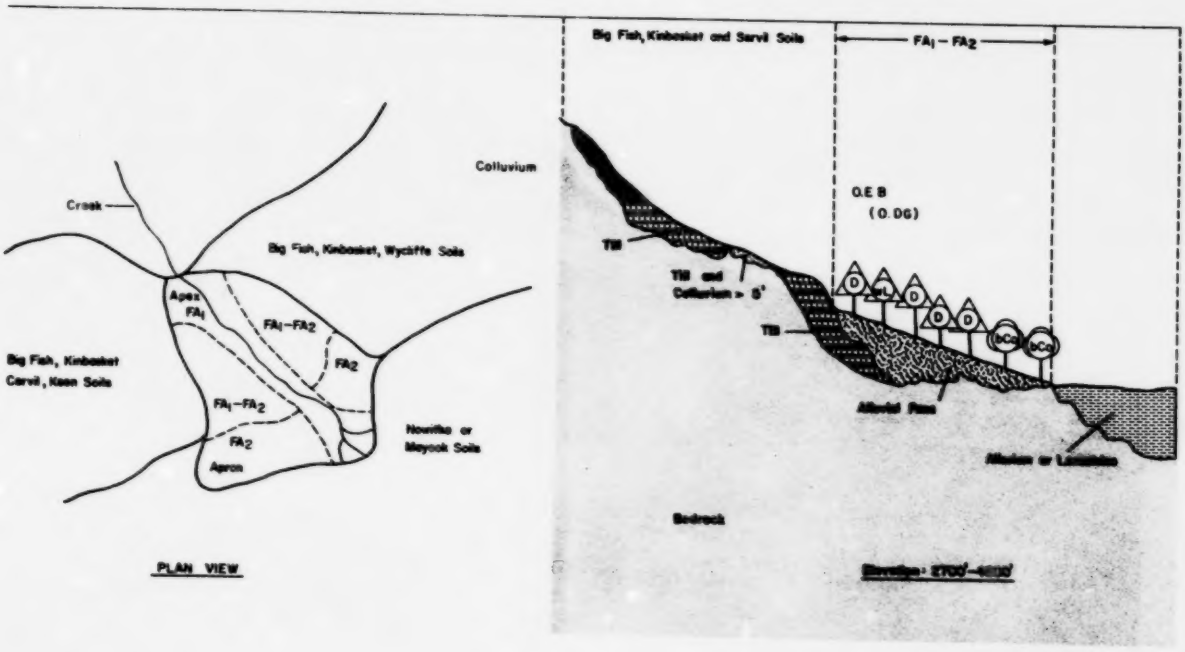
Carney soils are not suitable for agriculture. Mean annual increments of wood production are 50 to 110 cubic feet per acre per year for Engelmann spruce depending upon aspect, elevation and moisture status. In some more easily accessible areas, logging has occured.

FAIRMONT ASSOCIATION (FA)

Fairmont soils occur north of Invermere in the Rocky Mountain Trench. They have developed from moderately sloping fluvial fan deposits of streams which drain the Brisco Range and the Purcell Mountains into the Columbia River. Elevations range from 2700 to 4500 feet. The deposits are water sorted, partially stratified, and highly calcareous throughout. The gravelly sandy loam textures are generally coarse and stony but vary across the fan area. Coarser textures such as gravelly loamy sand are prevalent at the fan apex, while finer-textured deposits as sandy loam and loam are present on the fan aprons. Infiltration and permeability is rapid and the Fairmont soils are generally well to rapidly drained.

Soil development is variable. The modal soils are Orthic Eutric Brunisol. Orthic and Calcareous Dark Gray soils are present as significant inclusions. A few Orthic Regosols also occur. The variation in soil development largely depends on the susceptibility to, and intensity of freshet flooding and the amount of lime present.

The natural forest vegetation is Douglas-fir, with minor amounts of lodgepole pine and western larch. In the few seepage sites, willows, black cottonwood and birch are present. The ground



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Fairmont	FA1	Orthic Eutric Brunisol	r	.....		variable textured alluvial fan deposits	2700-4500	Interior Douglas-fir
	FA2	Orthic Eutric Brunisol	r	Orthic Dark Gray	r,w			

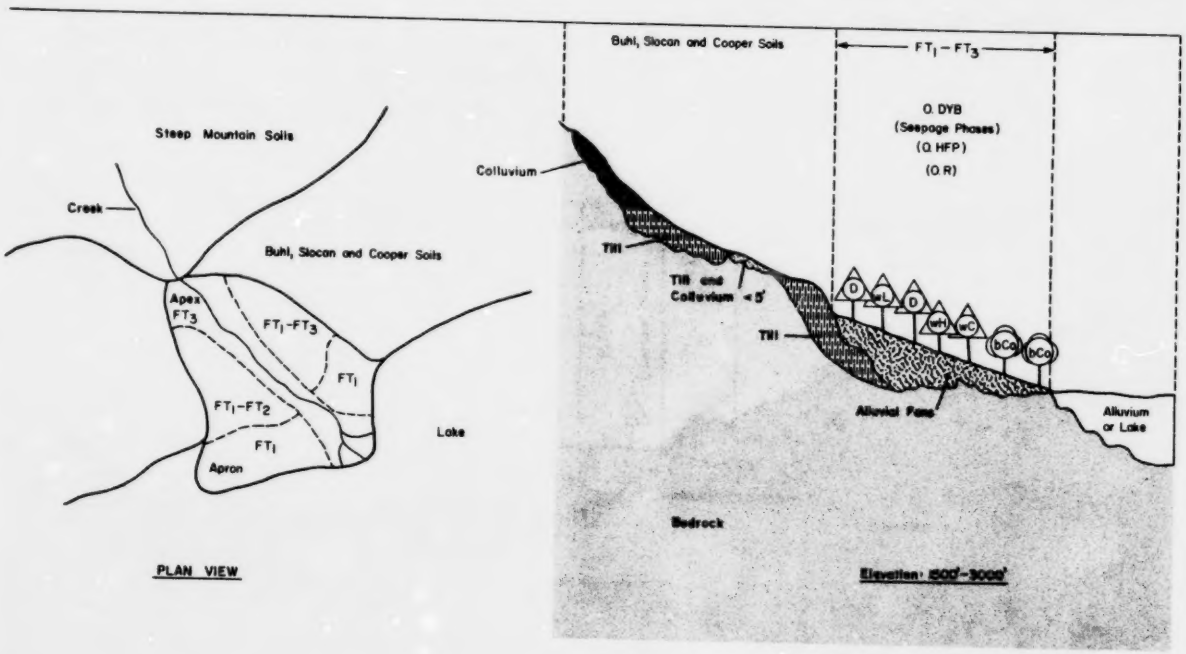
vegetation is pinegrass. The climate is characterized by dry and warm summers and cold winters and precipitation ranges up to 15 inches per year.

The capability of the soils for forestry ranges from 50 to 90 cubic feet per acre per year. Soil moisture deficiency and exposure are the main limitations. Agricultural capability is Class 4. The soils have some natural grazing potential. Stoniness and low water holding capacity are the dominant limitations. Fairmont soils are important wintering areas for deer and elk.

FRUITVALE ASSOCIATION (FT)

The Fruitvale soil association occurs in scattered locations throughout the western part of the map area, mainly along the Kootenay, Slocan and Duncan lakes and the Incomappleux River. Fruitvale soils have developed from fluvial fan deposits radiating outwards from points where streams leave the mountainous areas. The topography is moderately to steeply sloping. The fans usually contain many short, abandoned stream channels and a few occupied ones. Elevations range from about 1500 to 3000 feet. The soil parent material is poorly sorted, partially stratified, loosely compacted and permeable. Textures are generally coarse and stony near the fan apexes, while finer textures, usually gravelly loam or sandy loam, some silt loam and occasional clay loam occur on the fan apron. Drainage is variable and depends upon the soil texture, but generally the soils are well to rapidly drained. The soil parent materials are largely non-calcareous.

The main soil development of Fruitvale soils is Orthic Dystric Brunisol. They have moderately low base saturations, low cation exchange capacities and are strongly acid in reaction. Significant soil inclusions are Orthic Regosols which occur where freshet flooding is frequent. Orthic Humo-Ferric Podzol soil inclusions usually



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Fruitvale	FT1	Orthic Dystric Brunisol	w,r	seepage phases	i	variable textured alluvial fan deposits	1500-3000	Interior western hemlock
	FT2	Orthic Dystric Brunisol	w,r	Orthic Humo-Ferric Podzol	w,r			
	FT3	Orthic Dystric Brunisol	w,r	Orthic Regosol seepage phases	r i			

occur at the higher elevations, or in those areas with higher than usual precipitation.

The natural forest consists of western hemlock, western white pine, western red cedar and Douglas-fir.

Although these soils are often situated near large lakes which tend to moderate the climate, cold air drainage from higher elevations often causes a relatively short (less than 150 days) frost-free periods. The duration of the frost-free period depends on the fan size, slope and source of cold air. Precipitation ranges between 25 and 45 inches annually.

On the finer textured parts of the Fruitvale association and where the topography is moderate, the soils are capable of producing a wide range of crops including forages, coarse grains, vegetables and small fruits. Variable soil moisture holding capacities, usually low, can be overcome by irrigation.

The mean annual increment for forest growth ranges from 70 to 130 cubic feet per acre per year. The variability is due to variation in soil moisture deficiency and drainage, topography and presence of seepage.

GILLIS ASSOCIATION (GS)

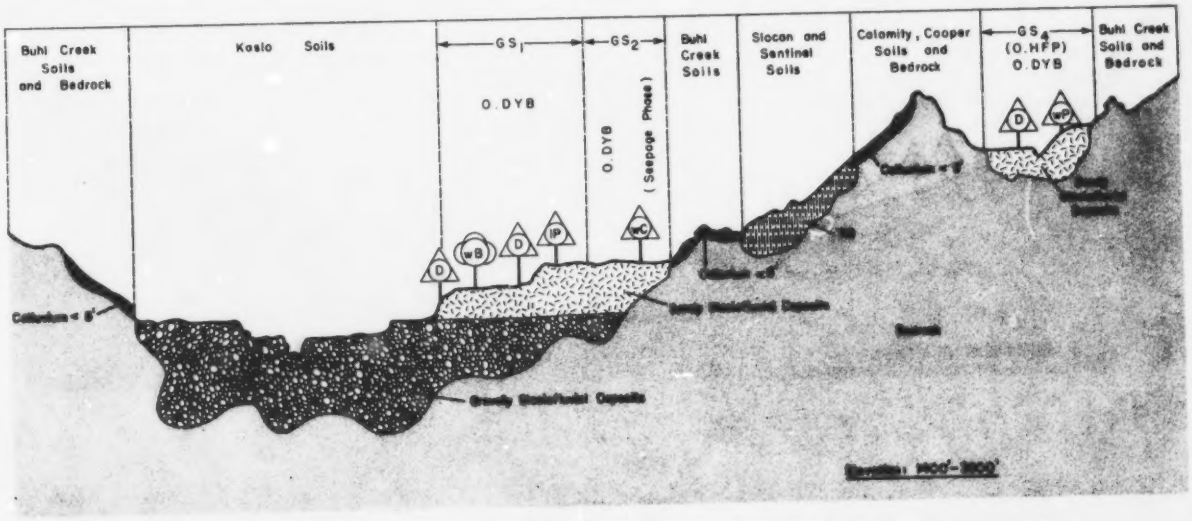
Gillis soils are confined mainly to the southwest portion of the map area, mostly along Arrow Park Creek, at elevations from about 1400 to 3500 feet. The parent material consists of glacial outwash terraces and deltas made up of sometimes stratified, highly permeable, loose sand. Surface drainage patterns are generally absent and the topography is gently sloping. The deposits are usually more than five feet deep and one or more layers of gravel is often present in the subsoil.

Gillis soils are rapidly drained. Seepage, however, above restricting layers at depth may occur where these are exposed, as in roadcuts and on escarpments.

Orthic Dystric Brunisol soil development is modal. Significant Orthic Humo-Ferric Podzol soil inclusions are also present at higher elevations. Cation exchange capacities and base saturations are very low due to the sandy textures.

The climate is generally warm and dry with a summer moisture deficit. Winters are also relatively mild because of the moderating effect of the Arrow Lakes. The vegetation is composed of western hemlock, lodgepole and white pine and Douglas-fir with white birch and western red cedar on seepage sites. Ground cover is composed of lichens and mosses.

Most of the Gillis soils are forested. The land capability for forestry is Class 3 or Class 4, moisture deficiency being the main limitation to forest growth. With irrigation and large applications of fertilizers these coarse textured soils are moderately capable of commercial production of most climatically adopted crops.



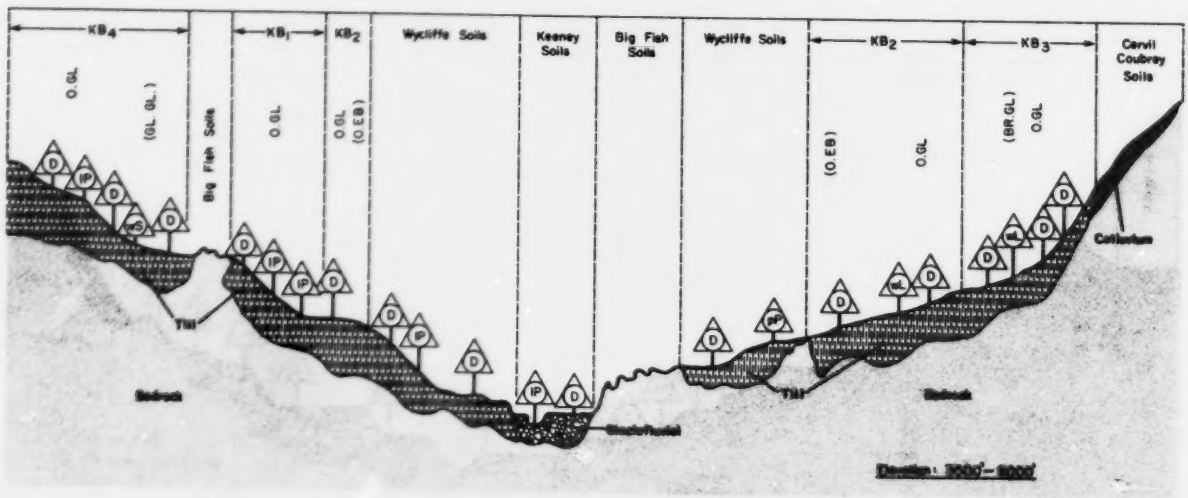
Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Gillis	GS1	Orthic Dystric Brunisol	r	.....		moderately coarse textured, well sorted sandy glaciofluvial deposits	1400-3500	Interior western hemlock - western red cedar
	GS2	Orthic Dystric Brunisol	r	seepage phase	i			
	GS4	Orthic Dystric Brunisol	r	Orthic Humo-Ferric Podzol	w			

KINBASKET ASSOCIATION (KB)

Kinbasket soils occur primarily north of Horsethief Creek in the Rocky Mountain Trench on rolling and hummocky, drumlinized glacial till at elevations between 3500 and 5000 feet. The parent material is compact, moderately calcareous, medium textured and moderately stony. A very fine sandy or silty windblown deposit up to 10 inches thick usually covers the surface.

The modal soil development is Orthic Gray Luvisol. Surface textures are usually fine sandy loam or loam underlain by gravelly sandy loam or gravelly loam; the Bt horizon is often clay loam. Most Kinbasket soils are well drained, have moderate cation exchange capacities, high base saturations and neutral to mildly alkaline reactions. Free lime usually occurs at about 15 inches below the soil surface. Significant soil inclusions are Orthic Eutric Brunisols, Brunisolic Gray Luvisols and Gleyed Gray Luvisols. The Orthic Eutric Brunisols occur primarily south of Radium where the climate is somewhat dryer. Brunisolic Gray Luvisol soils become more dominant at higher elevations where slightly higher amounts of precipitation and cooler temperatures prevail. The Gleyed Gray Luvisols tend to occur in depressions and other moisture receiving areas.

The climate is moderately warm and dry (about 10 to 15 inches annual precipitation and fewer than 120 frost-free days) and is similar to that of the closely associated Wycliffe soil association. The



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Kinbasket	KB1	Orthic Gray Luvisol	w	.....		medium to moderately fine textured calcareous basal till	3500-5000	Interior Douglas-fir
	KB2	Orthic Gray Luvisol	w	Orthic Eutric Brunisol	w			
	KB3	Orthic Gray Luvisol	w	Brunisolic Gray Luvisol	w			
	KB4	Orthic Gray Luvisol	w	Gleyed Gray Luvisol	i			

forest consists of medium to dense stands of Douglas-fir interspersed with lodgepole pine, willows, white birch, trembling aspen and minor amounts of western larch.

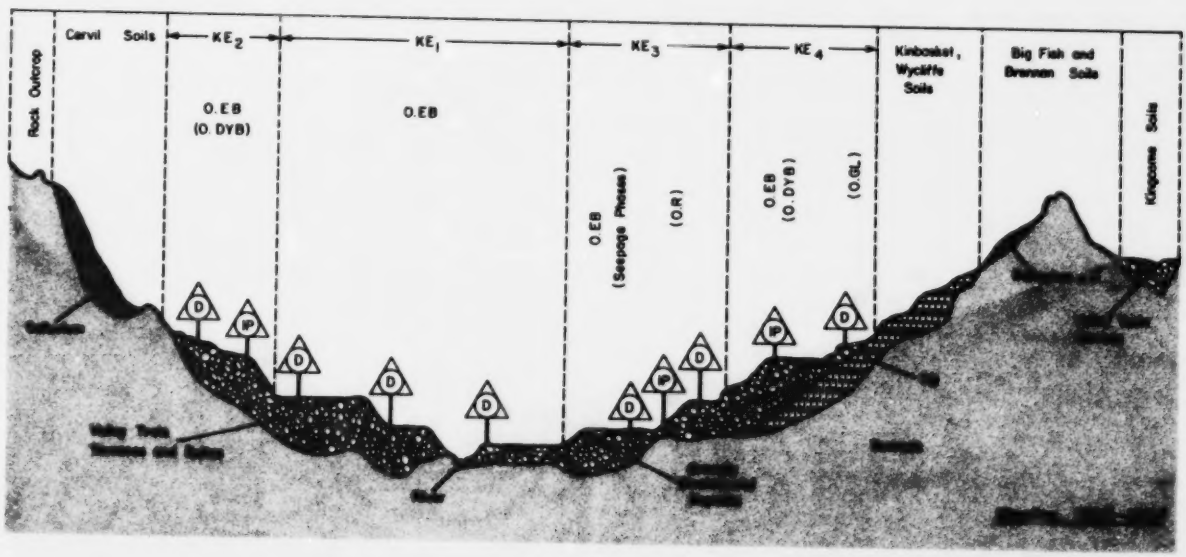
The land capability for forestry ranges from Class 3 to Class 5, with soil moisture deficiency being the main limitation. A few areas have been cleared for agricultural use. Irrigation and stone clearing are necessary for good agricultural production. The soils are moderately suitable as wildlife (deer and elk) winter ranges.

KEENEY ASSOCIATION (KE)

Keeney soils occur in association with Kinbasket and Wycliffe soils in the Rocky Mountain Trench northwest of Invermere. The soils have developed on flat to gently sloping glacial outwash terraces, deltas, plains and valley trains, and on gravel filled channels among the drumlinized glacial till. The parent material consists mainly of gravel interstratified with some sand, and is stony, highly permeable and loose. Calcareous rock fragments are present and lime accumulation is visible in the subsoil. The deposits are of variable depth, but generally exceed five feet. Elevations range from about 3000 to 5000 feet.

The modal soil development is Orthic Eutric Brunisol. The upper solum is slightly acid in reaction and is usually sandy loam or loamy sand in texture and contains variable amounts of gravel. The gravelly loamy sand or gravelly sand parent material is moderately alkaline. Significant inclusions of Orthic Dystric Brunisols occur at higher elevations, while Orthic Gray Luvisols sometimes occur where textures are somewhat finer than usual.

Keeney soils occur in the Interior Douglas-fir zone where the climate is dry (less than 15 inches total annual precipitation) and moderately warm (up to 120 frost-free days per year). The trees dominantly consist of Douglas-fir, lodgepole pine and trembling aspen. Some birch and Ponderosa pine grow in the extreme southeastern part of the map



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Keeney	KE1	Orthic Eutric Brunisol	r	.....		loose, well to poorly sorted (often calcareous) moderately coarse textured glaciofluvial deposits	3000-5000	Interior Douglas-fir
	KE2	Orthic Eutric Brunisol	r	Orthic Dystric Brunisol	r			
	KE3	Orthic Eutric Brunisol	r	Orthic Regosol seepage phases	r i			
	KE4	Orthic Eutric Brunisol	r	Orthic Gray Luvisol Orthic Dystric Brunisol	w w,r			

Keeney Association (Cont'd)

area.

The soils are presently forested and land capability for forestry ranges from Class 5 to Class 7. The main limitations are soil moisture deficiency and aridity. Limited agriculture with climatically adapted crops is possible on the less stony soils, if they are adequately irrigated.

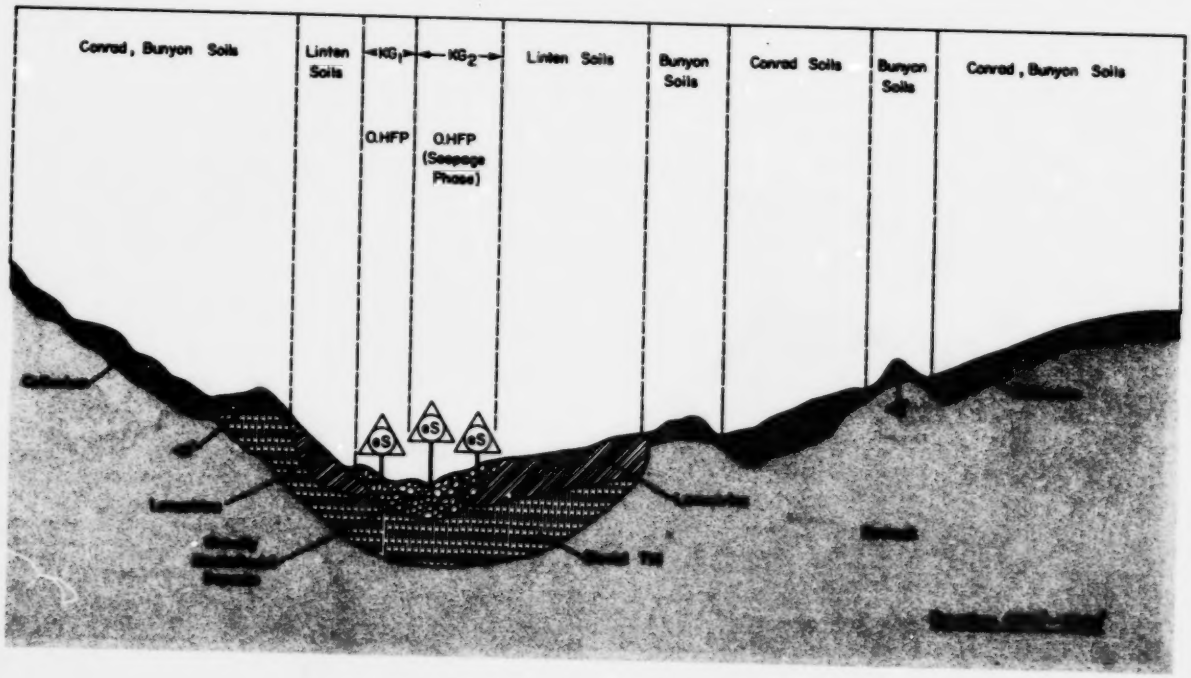
KINGCOME ASSOCIATION (KG)

Kingcome soils are mapped in the Vowell, Jumbo, Horsethief and Toby creek drainage basins in the northeastern part of the map area, between elevations of 4500 and 5500 feet. The soil parent material consists of level to rolling glaciofluvial terrace remnants, and other glaciofluvial deposits located along the lower valley sides. It is gravelly, stratified, moderately coarse textured, and loose. Depth of the deposits is variable but usually exceeds five feet. Typical soil textures are gravelly loamy sand or sandy loam. Drainage is rapid, except in seepage areas where it is imperfect.

Modal soil development is Orthic Humo-Ferric Podzol. The soil is characterized by low cation exchange capacities and moderately low base saturation. Soil reaction ranges from very strongly acid in the solum to strongly acid in the parent material.

The climate is characterized by a cool and relatively dry growing season (less than 60 frost-free days and about 15 inches seasonal precipitation). The main tree species are Engelmann spruce, alpine fir, and lodgepole pine.

Kingcome soils are rated Class 4 for forestry capability. Cold temperatures and soil moisture deficiency are their main limitations.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Kingcome	KG1	Orthic Humo-Ferric Podzol	r	.....		coarse textured, well sorted gravelly glaciofluvial deposits	4500-5500	Subalpine Engelmann spruce - alpine fir
	KG2	Orthic Humo-Ferric Podzol	r	seepage phase	i			

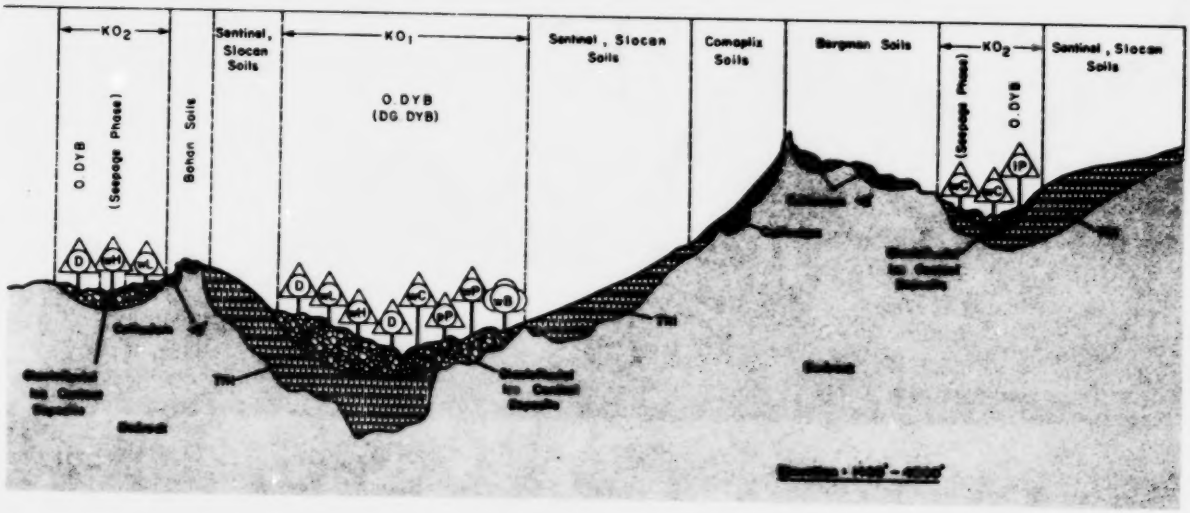
KASLO ASSOCIATION (KO)

The Kaslo soils are found in most river and creek valleys in the western part of the map area at elevations ranging from 1400 to 4000 feet. The parent materials are level to rolling glaciofluvial deposits which occur as hummocks, mounds and terraces along the valley sides. They are poorly sorted, moderately coarse textured, often very stony, usually slightly compacted and of variable permeability and depth. Most of the Kaslo soils are rapidly drained. Seepage, however, occurs above restricting layers which are finer textured and more compact.

The typical soil development is Orthic Dystric Brunisol and is characterized by moderately high base saturation, very low exchange capacity and medium acid reaction. Significant Degraded Dystric Brunisol soil inclusions, as well as seepage phases, are mapped in conjunction with the modal soil. Kaslo soils have a deep solum, often in excess of five feet.

The associated climate is moderately dry and warm. The vegetation is dominantly western hemlock, with western white pine, lodgepole pine, western red cedar, white birch and some black cottonwood.

The land capability for forestry is highly variable and rages from Class 1a to 5. The best capability classes occur where the textures are finer than usual and where seepage exists. Most Kaslo soils are non-arable owing to the combination of coarse soil textures, stoniness, and, in many areas, relatively steep topography.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Kaslo	KO1	Orthic Dystric Brunisol	r	Degraded Dystric Brunisol	r	loose, well to poorly sorted moderately coarse textured glacio-fluvial ice contact deposits	1400-4000	Interior western hemlock - western red cedar
	KO2	Orthic Dystric Brunisol	r	seepage phase	i			

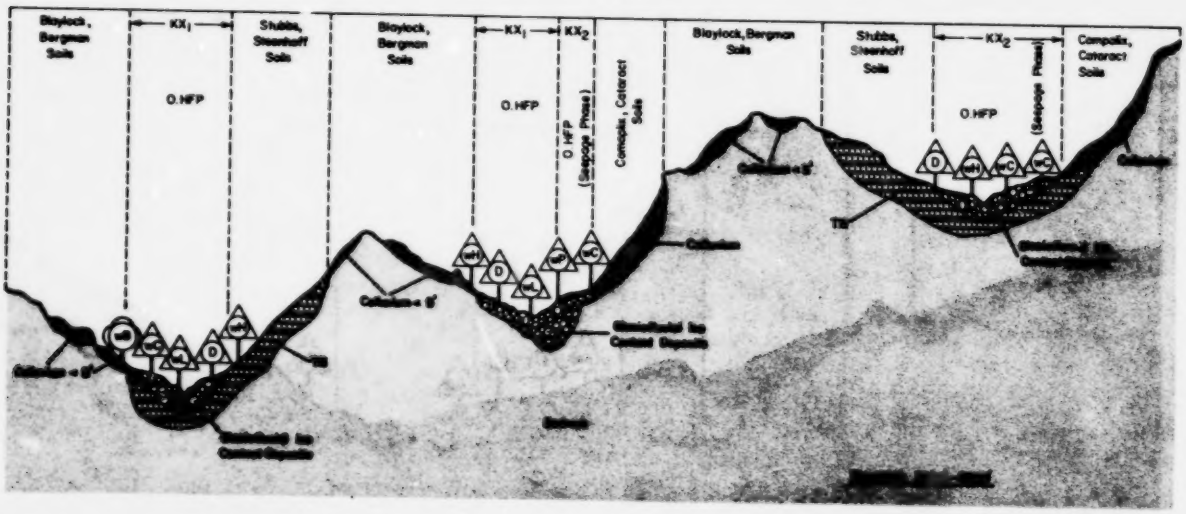
KUSKANAX ASSOCIATION (KX)

Kuskanax soils occur in the western half of the map area in the upper parts of the drainages of most valleys, at elevations from 3500 to 5500 feet. The topography is level to rolling. The landforms consist of terrace remnants, ice contact deposits and other glaciofluvial deposits occurring on the valley floors and lower valley slopes. They are similar to those of the Kaslo soil association. The deposits consist primarily of partially sorted sand and gravel. They are stony, loose, and of variable permeability and depth. Kuskanax soils are usually rapidly drained except for seepage phases, which are imperfectly drained.

Typical soil development is Orthic Humo-Ferric Podzol and is characterized by a deep solum having well developed Ae and Bf horizons. Soil reaction is strongly acid and cation exchange capacities are moderately low.

The climate is cool and moist. The forests are dominantly overmature western hemlock with western red cedar in moister and seepage sites. Engelmann spruce is often present at higher elevations.

Capabilities for forestry range from Class 1a to Class 5 depending upon soil moisture conditions, temperature, and soil texture. Kuskanax soils are mostly non-arable due to stoniness, low moisture holding capacity, short frost-free periods and in some locations, adverse topography.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Kuskanax	KX1	Orthic Humo-Ferric Podzol	r	.....		loose, well to poorly sorted moderately coarse textured glacio-fluvial ice contact deposits	3500-5500	Interior western hemlock - western red cedar
	KX2	Orthic Humo-Ferric Podzol	r	seepage phase	i			

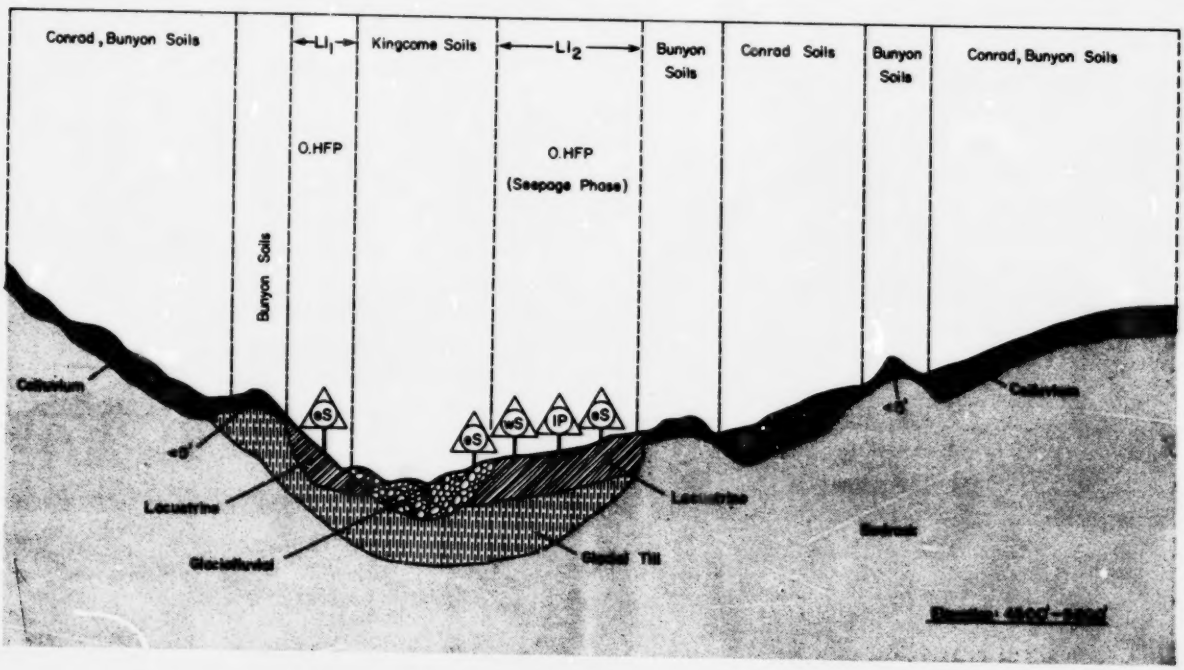
LINTEN ASSOCIATION (LI)

The Linten soils are mapped only in the upper parts of Vowell and Malloy creek valleys and in the tributaries of Bobbie Burns Creek in the northeast part of the map area. Elevations range from about 4500 to 5500 feet. The topography is flat to gently sloping and sometimes strongly rolling. The soil parent material consists of localized glacio-lacustrine sediments, usually one to five feet thick, which overlie glaciofluvial or glacial till deposits. The majority of the soils are well drained, however, in seepage areas imperfect drainage is indicated by mottling in the solum and parent material.

Typical soil development is Orthic Humo-Ferric Podzol. The soils are very strongly acid and have moderate cation exchange capacities. Textures generally range from sandy loam to clay loam in the solum with loam and silt loam being most common.

Linten soils have developed in a relatively cool and moist climate. The associated forests consist of Engelmann spruce, alpine fir and lodgepole pine.

The soils have very limited agricultural potential mainly because of a short frost-free period. Land capability for forestry ranges from Class 3 to Class 4 for lodgepole pine. Cold temperatures and soil moisture deficiency are the limiting factors.



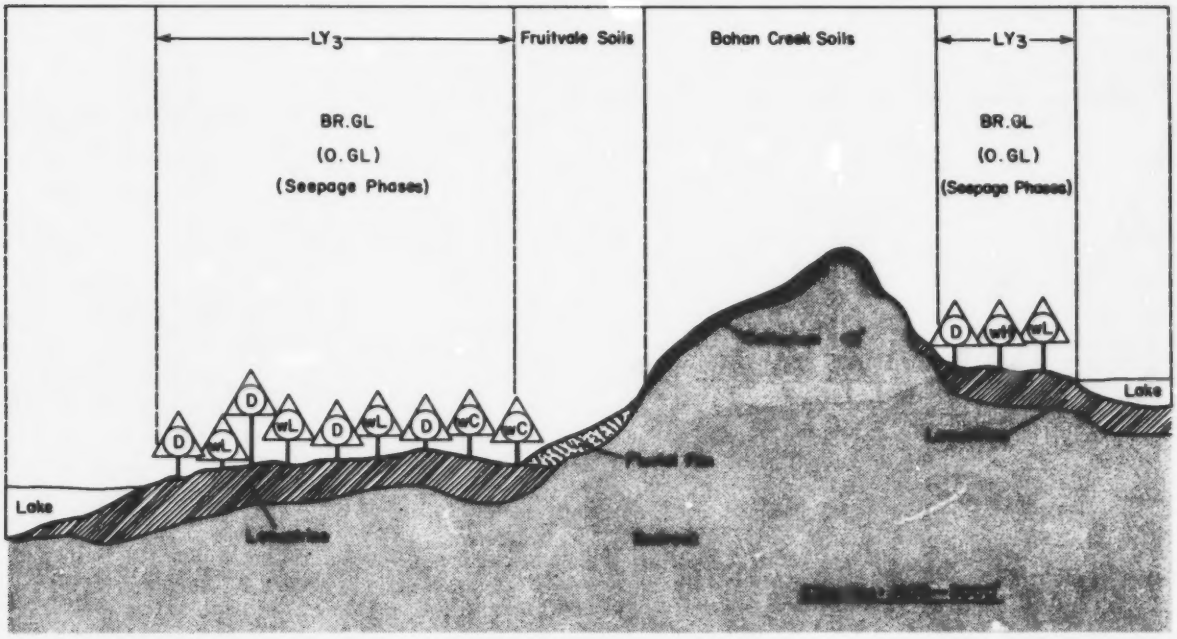
Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Linten	LI1	Orthic Humo-Ferric Podzol	w	.....		moderately fine textured lacustrine deposits	4500-5500	Subalpine Engel-mann spruce - alpine fir
	LI2	Orthic Humo-Ferric Podzol	w	seepage phase	i			

LAWLEY ASSOCIATION (LY)

Lawley soils occur between Nakusp and Burton along the Arrow Lakes at elevations between 1400 and about 3000 feet. The topography is undulating to moderately rolling. The soil parent material is composed of medium and moderately fine textured glaciolacustrine sediments which are generally stone-free, layered, compact, and slowly permeable. Textures sometimes become slightly coarser at depth. Soil textures in the solum usually range from loam to silt loam. The soils are moderately well to well drained.

Modal soil development is Brunisolic Gray Luvisol. The characteristic Bm, Ae and Bt horizons are well developed. The soils have moderately high cation exchange capacities and high base saturation. Soil reaction is medium acid. Significant soil inclusions are Orthic Gray Luvisols and these tend to be dominant in areas where textures are finer than usual.

The climate, typical of the interior valleys is relatively dry and warm. The Columbia River-Arrow Lake valley has a growing season precipitation of up to 10 inches and a frost-free



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Lawley	LY3	Brunisolic Gray Luvisol	w	Orthic Gray Luvisol seepage phases	w i	moderately fine textured lacustrine deposits	1400-3000	Interior western hemlock - western red cedar

period of about 150 days. The native trees include western hemlock, Douglas-fir, western white pine and lodgepole pine with western red cedar in seepage locations. A variety of fairly dense shrub and understory cover is also present.

The combination of suitable climatic conditions and topography with adequate soil texture make these soils attractive for agricultural use. Capability ranges from Class 1 to Class 4. Almost all of these soils were used for agriculture at one time before the area was utilized for water storage. Abandoned orchards still dot the landscape among excellent western white pine regeneration.

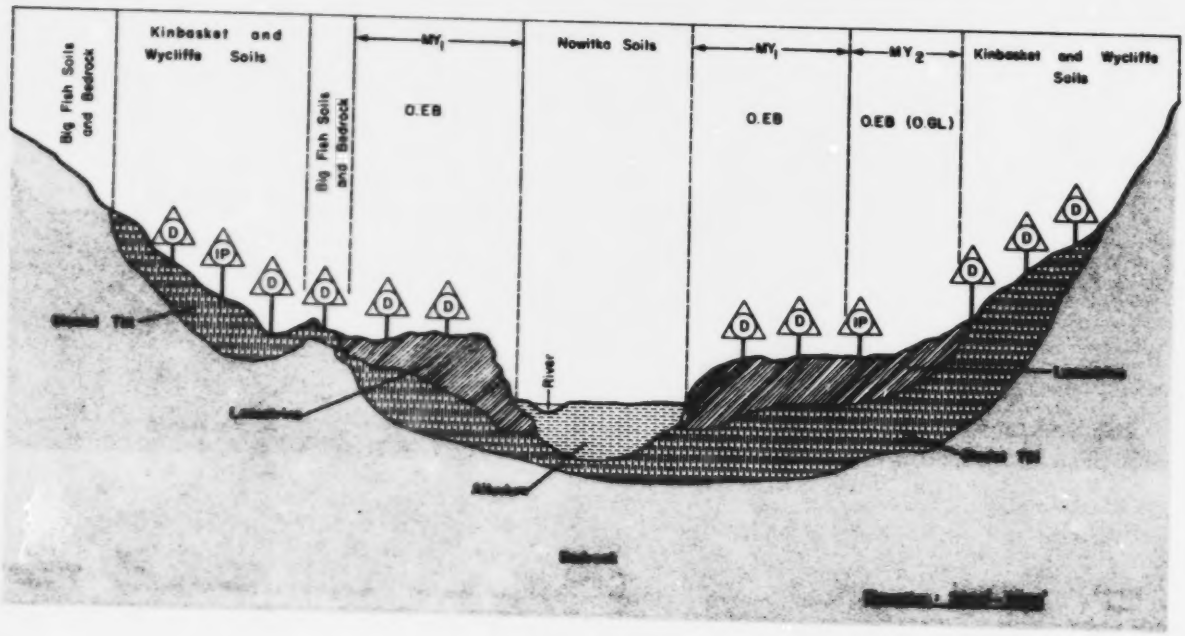
Lawley soils are also well suited for forest production mainy due to their adequate water holding capacity and the long growing season.

MAYOOK ASSOCIATION (MY)

Mayook soils occur in the Rocky Mountain Trench at elevations between 2600 and 3500 feet, and in small isolated pockets in the lower Findlay Creek drainage. The landforms are generally flat to rolling and are incised by many small, steep gullies and ravines. These gullies are up to a half mile long. Some have merged, leaving level topped areas (islands) surrounded by channels. The parent material consists of deep, well stratified, calcareous predominantly silt loam textured glaciolacustrine sediments. Inclusions of loam and very fine sandy loam sometimes occur, due in part to an intermittent surface capping of aeolian material up to 18 inches thick.

The sola are thin and modal soil development is Orthic Eutric Brunisol. Free lime may sometimes be found at the surface but it generally occurs at about five inches depth. A significant soil inclusion is Orthic Gray Luvisol which is found generally north of Brisco, under slightly moister conditions. Some Orthic Eutric Brunisols have weakly developed Ah horizons. These are typically found under pinegrass and scattered tree cover and are trending toward Dark Gray soils.

The climate is dry and moderately warm (growing season precipitation is less than 8



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Mayook	MY1	Orthic Eutric Brunisol	w	.....		moderately fine textured lacustrine deposits	2600-3500	Interior Douglas-fir
	MY2	Orthic Eutric Brunisol	w	Orthic Gray Luvisol	w			

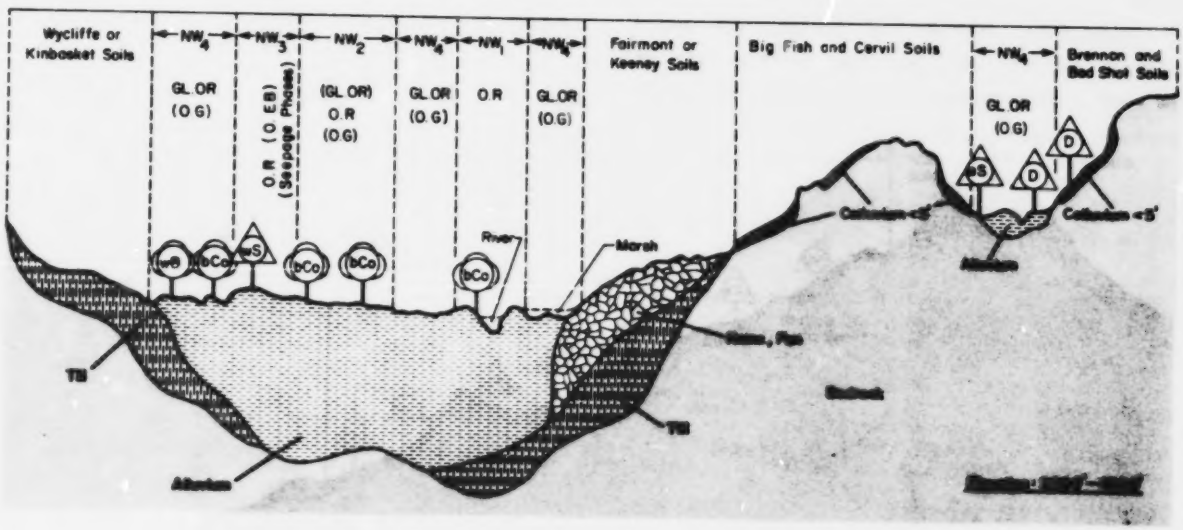
inches and the frost-free period is less than 120 days). The open tree cover consists mainly of Douglas-fir, with minor amounts of trembling aspen, lodgepole pine and ponderosa pine. Juniper shrubs are dominant in the understory.

Land capabilities for forestry are low, ranging from mean annual increments of 10 to 50 cubic feet per acre per year. The main limitations to tree growth are climatic aridity, high lime content in the soil and high incidence of soil erosion. The soils, when irrigated, have the best agricultural capability within the Rocky Mountain Trench section of the map area.

NOWITKA ASSOCIATION (NW)

Nowitka soils occur in the valley bottoms of the East Kootenays. Specifically, they exist on the floodplains of the Columbia and Kootenay rivers and in small pockets along Bobbie Burns, Francis, Forster, Horsethief, Dutch, Toby and Findlay creeks. The Nowitka soils have developed on rolling and undulating recent fluvial (alluvial) deposits. These stratified sediments are generally moderately coarse to medium textured, calcareous, and range from fine sand to silt loam with occasional lenses of gravel and clay. They are commonly flooded during spring and summer by annual freshets which add new sediments to the surface and retard soil horizon development. The fluctuating water table causes alternate oxidizing and reducing conditions that stain the deposits with mottles.

Soil development is variable, ranging from Orthic Regosol to Orthic Gleysol, and is dependent upon the texture of the parent material, variation in soil drainage, frequency of flooding and proximity of stream, river and groundwater. The dominant soil, however, is Orthic Regosol which is characterized by calcareous, variable-textured,



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range (feet)	Forest Zone
Nowitka	NW1	Orthic Regosol	r,w	.....		medium textured alluvium	2600-4500	Interior Douglas-fir
	NW2	Orthic Regosol	r,w	Gleyed Orthic Regosol Orthic Gleysol	i p,v			
	NW3	Orthic Regosol	r,w	Orthic Eutric Brunisol seepage phases	w i			
	NW4	Gleyed Orthic Regosol	i	Orthic Gleysol	p,v			

well drained strata. Significant soil inclusions are Gleyed Orthic Regosols, Orthic Eutric Brunisols and Cumulic Regosols. The latter soils result where intermittent flooding has buried weakly developed Ah horizons. The Orthic Eutric Brunisols are found on the highest areas which have been relatively unaffected by flooding for a number of years. Orthic Gleysols are usually found in depressional areas permanently affected by groundwater. Most Nowitka soils are calcareous throughout the profile. Low cation exchange capacities and moderately alkaline conditions prevail.

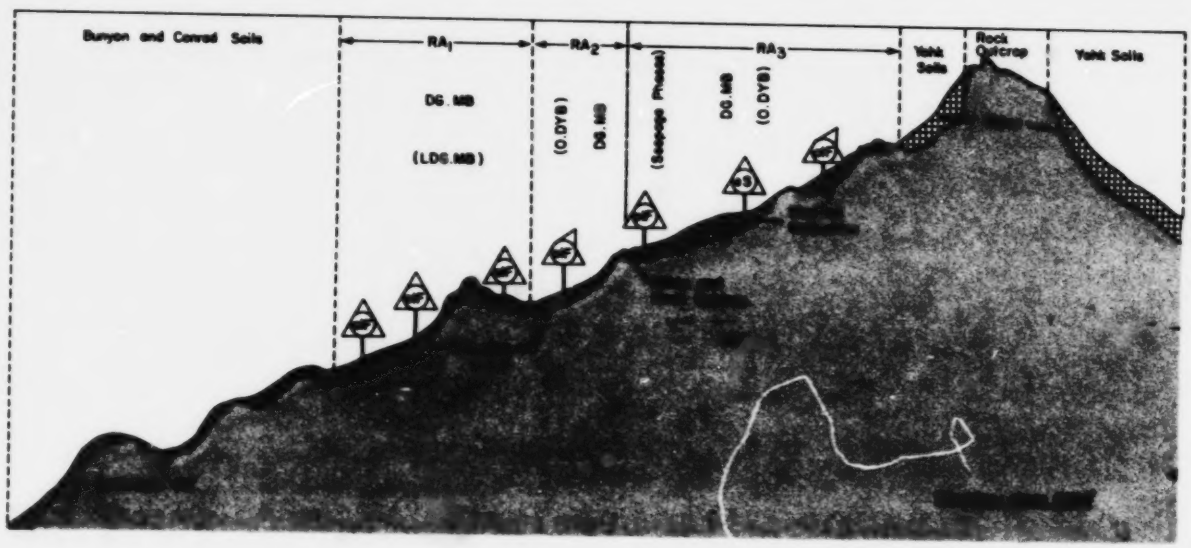
Vegetation includes a variety of water tolerant species, salt and lime tolerant grasses and reeds, and occasional willow and birch. Sedges dominate in poorly drained areas, while shrubs and black cottonwood occupy the higher, better drained positions. Nowitka soils tend to occur in areas of frost pooling and have frost-free periods generally not exceeding 90 days.

Most Nowitka soils that are flooded in the spring and summer are not utilized for cultivated agriculture at the present time. Limited acreages in higher positions have better soil drainage and can be used for hay, oats,clover, barley and cool season vegetables. Nowitka soils are used intensively by waterfowl and this may be the best use until agricultural pressure becomes great enough to require reclamation.

RADIUM ASSOCIATION (RA)

Radium soils are mapped in the alpine areas of the eastern third of the map area, at elevations in excess of 6500 feet. The soils occur on moderately and steeply sloping upper slopes, ridge-crests, cirque basins and saddles. The parent material is colluvium generally less than three feet in depth which overlies a variety of bedrock. The colluvium is moderately coarse textured, permeable, loose, stony and bouldery and is strongly affected by physical weathering and frost action. Periglacial processes, such as nivation and solifluction are active. Most Radium soils are well drained; those in hollows and in seepage areas are imperfectly drained.

The modal soil development appears to be Degraded Melanic Brunisol. The sampled soil profile has a high cation exchange capacity in the Ah horizons which decreases with depth and soil reaction is neutral throughout the profile. In other areas, Radium soils have higher chromas in the B horizon and less organic matter accumulation in the A horizon more typical of Orthic Dystric Brunisols. Significant soil inclusions are seepage and lithic phases of Orthic Dystric and Orthic Melanic Brunisols. Orthic Sombric Brunisols and Orthic Humo-Ferric Podzols also occur in apparently insignificant quantities. The variations in profile development at these high elevations largely depend on aspect, soil drainage, type of bedrock and possibly, type of vegetation.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Radium	RA1	Degraded Melanic Brunisol	w	Lithic Degraded Melanic Brunisol	w	shallow, moderately coarse textured colluvium overlying bedrock	6500+	Alpine Tundra
	RA2	Degraded Melanic Brunisol	w	Orthic Dystric Brunisol	w			
	RA3	Degraded Melanic Brunisol	w	Orthic Dystric Brunisol seepage phases	w i			

The Radium soils occur in a harsh environment characterized by cold temperatures, moderately deep snowfall and strong winds. Most soils are shallow with turfy surfaces because of the dominance of alpine forb and grass vegetation. Trees are absent or occur only as small groves of dwarfed and deformed (krummholz) forms. The severity of climate is the dominant feature of this very fragile landscape.

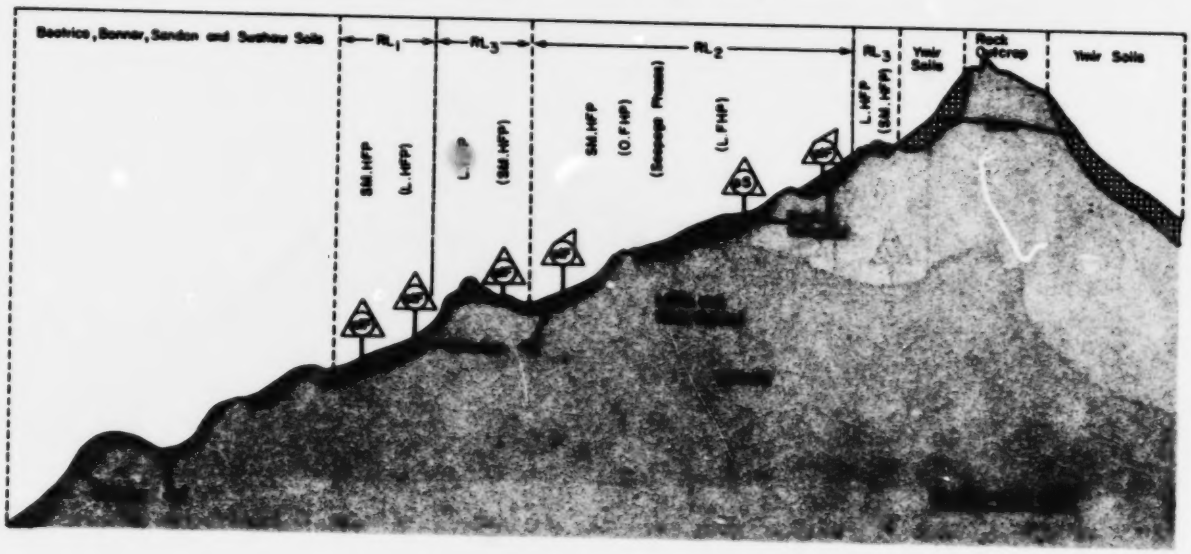
The Radium soils are non-arable and not forested. They form a suitable habitat for summer grazing by both domestic and wild ungulates. The extensive recreational potential is unexcelled for hiking, riding, and viewing.

ROSSLAND ASSOCIATION (RL)

Rossland soils are found above timberline at elevations in excess of about 6500 feet in the western half of the map area. The soils occur on the upper slopes, ridges, depressions and cirque basins in mountainous topography. The parent material is colluvium, the surface pattern of which shows a high degree of frost action, including nivation hollows and related frost upheaving and downslope movement. The material is shallow, moderately coarse to medium textured, permeable, loose, stony and bouldery. Hard or partially weathered bedrock is often encountered within three to five feet from the surface. The bedrock composition is variable but is usually medium grained and non-calcareous.

Typical soil development is Sombric Humo-Ferric Podzol for the well and moderately well drained Rossland soils. They are characterized by extremely acid reactions and low base saturations. Cation exchange capacities in surface horizons are high largely because of the high amount of organic matter present. Significant soil inclusions are Orthic and Lithic Humo-Ferric and Ferro-Humic Podzols.

The environment is characterized by very short, cool growing seasons, cold temperatures, deep snowfall and strong winds. Under these conditions the shallow turfy soils support a variety of shrubs, forbs, sedges and grasses which rarely grow over a foot tall.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Rossland	RL1	Sombric Humo-Ferric Podzol	w,mw	Lithic Ferro-Humic Podzol	w,r	shallow, medium to moderately coarse textured colluvium overlying bedrock	6500+	Alpine Tundra
	RL2	Sombric Humo-Ferric Podzol	w,mw	Orthic Ferro-Humic Podzol	w			
				Lithic Ferro-Humic Podzol	w,r			
				seepage phases	i			
	RL3	Lithic Humo-Ferric Podzol	w,r	Sombric Humo-Ferric Podzol	mw			

Rossland Association (Cont'd)

Rossland soils are unsuitable for agricultural or forestry uses, but provide domestic and wild ungulate summer ranges. They are excellent for extensive recreational uses, such as hiking, riding and viewing. Intensive use is likely to damage the fragile alpine environment.

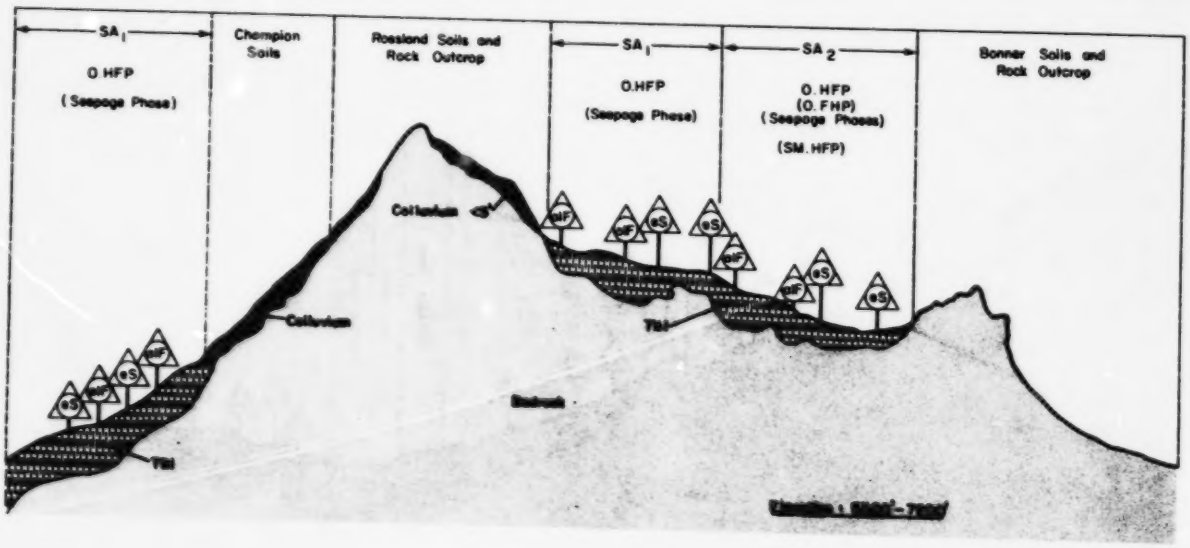
SANDON ASSOCIATION (SA)

A small acreage of Sandon soils are mapped near Beaton and east of New Denver. They occur on moderately steep to steep upper slopes, in cirque basins and depressions at elevations ranging from about 5500 to 7200 feet. The parent material is a medium-textured mixture of glacial till and colluvium usually deeper than 5 feet. Shale, slate, phyllite and schist are the dominant rock fragments in the till-colluvium mixture.

The modal soil development is Orthic Humo-Ferric Podzol. Significant soil inclusions are Orthic Ferro-Humic and Sombric Humo-Ferric Podzols, as well as the associated seepage phases of these soils. The soils are generally well drained, but seepage phases found in depressional areas are imperfectly drained.

The Sandon soils have developed under moist and cool (less than 20 inches May to September precipitation and fewer than 30 frost free days) climatic conditions typical of the Subalpine Engelmann spruce-alpine fir forest zone. The dominant trees are alpine fir and Engelmann spruce. Whitebark pine, lodgepole pine, and a few mountain hemlock are also present, often in stunted forms and in sheltered locations.

Sandon soils have low capability for forestry and very limited grazing potential for wildlife.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Sandon	SA1	Orthic Humo-Ferric Podzol	w	seepage phase	i	medium textured basal till	5500-7200	Subalpine Engelmann spruce - alpine fir (krummholz)
	SA2	Orthic Humo-Ferric Podzol	w	Orthic Ferro-Humic Podzol Sombric Humo-Ferric Podzol seepage phases	w mw i			

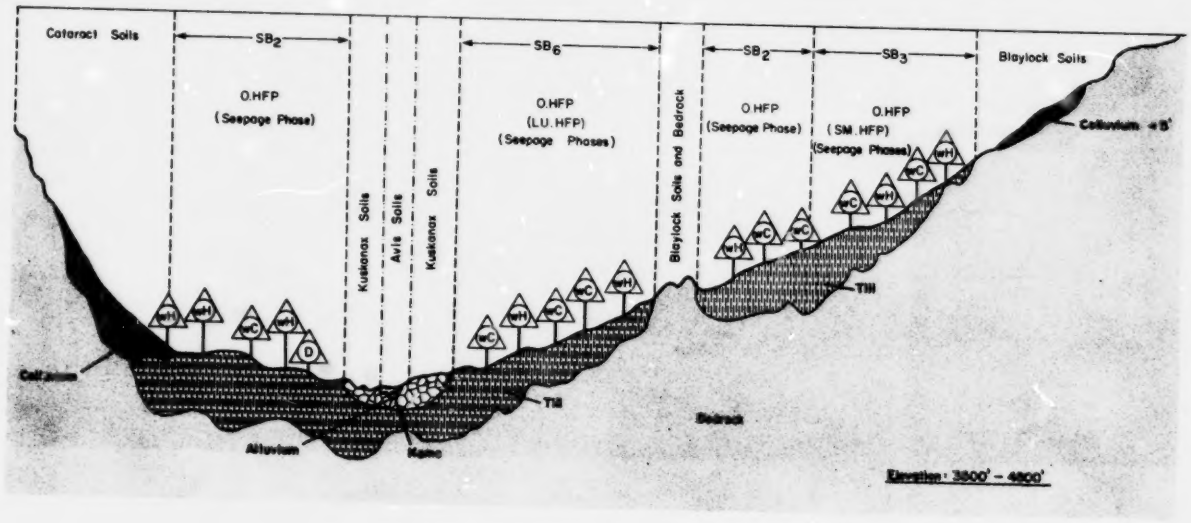
STUBBS ASSOCIATION (SB)

Stubbs soils are found south and east of Trout Lake in the Lardeau River valley; they range in elevation from about 3500 to 4800 feet. Stubbs soils occur on middle to upper mountain slopes that are covered by morainal (glacial till) deposits. Generally, the topography is moderately to steeply sloping and somewhat more severe than that of the related Sentinel soils found at lower elevations. The soil parent material is generally medium to moderately fine textured, stony glacial till although somewhat coarser-textured areas are also present.

These well-drained soils are mainly Orthic Humo-Ferric Podzols characterized by medium to strongly acid reactions and medium base saturations. Significant soil inclusions are Sombric Humo-Ferric Podzol and Luvisolic Humo-Ferric Podzol. The former are associated with seepage sites while the latter occur in areas of somewhat finer-textures where clay has accumulated in the solum.

The climate is moist and cool. The vegetation is mostly mature and over-mature western hemlock. Minor amounts of Douglas-fir, Engelmann spruce together with western red cedar, lodgepole pine and western larch are found throughout.

Excellent capabilities for forest growth make these soils attractive for tree production. However, cool temperatures and soil moisture deficiency together with adverse topography may impose some limitations.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Stubbs	SB2	Orthic Humo-Ferric Podzol	w	seepage phase	i	shallow, medium to fine textured colluvium overlying basal till	3500-4800	Interior western hemlock - western red cedar
	SB3	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i			
	SB6	Orthic Humo-Ferric Podzol	w	Luvisolic Humo-Ferric Podzol seepage phases	w i			

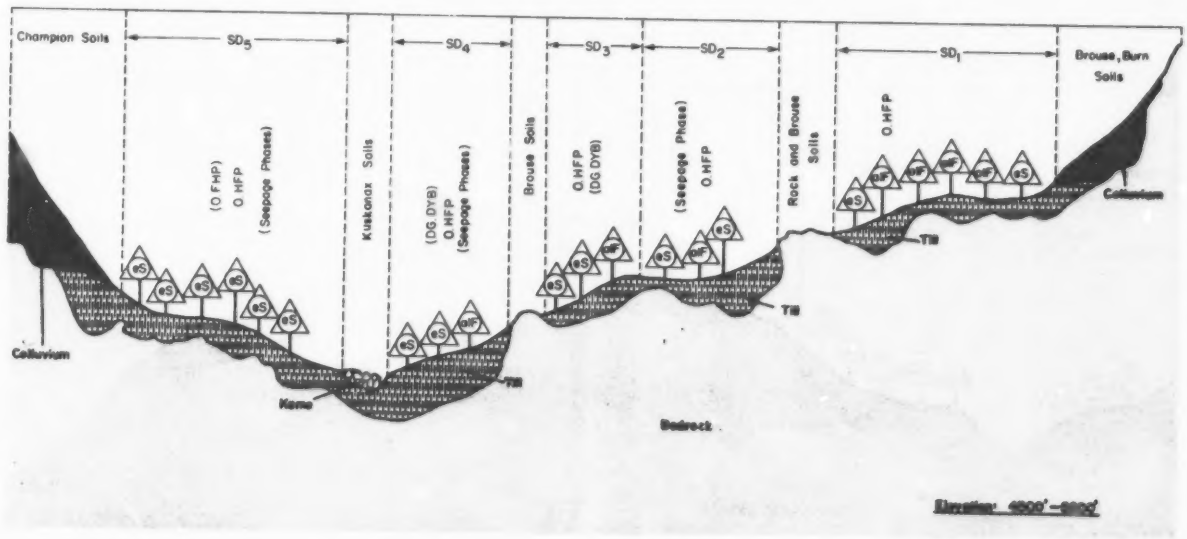
SANDNER ASSOCIATION (SD)

Sandner soils occur in only a few areas and are mapped in conjunction with other soils near New Denver, at elevations from about 4500 to 5800 feet. They are mapped on the upper, moderately steep mountainous slopes which are covered with deep glacial till generally containing fine-grained rock fragments.

Typical soil development is Orthic Humo-Ferric Podzol with Degraded Dystric Brunisol and Orthic Ferro-Humic Podzol as significant soil inclusions. The Degraded Dystric Brunisols occur mostly at the lower elevations while the Orthic Ferro-Humic Podzols occur in depressional areas and seepage sites which are moister than usual. Most soils are well drained except for seepage areas, which are usually imperfectly drained. Soil textures generally range from gravelly loam to gravelly silt loam and, occasionally to gravelly clay loam.

The environment is characterized by a cool and moist climate, having less than 18 inches of May to September precipitation and less than approximately 90 frost-free days. The main trees are Engelmann spruce and alpine fir.

The soils are presently under forest and the mean annual increments for forest growth range from 90 to 110 cubic feet per acre per year.

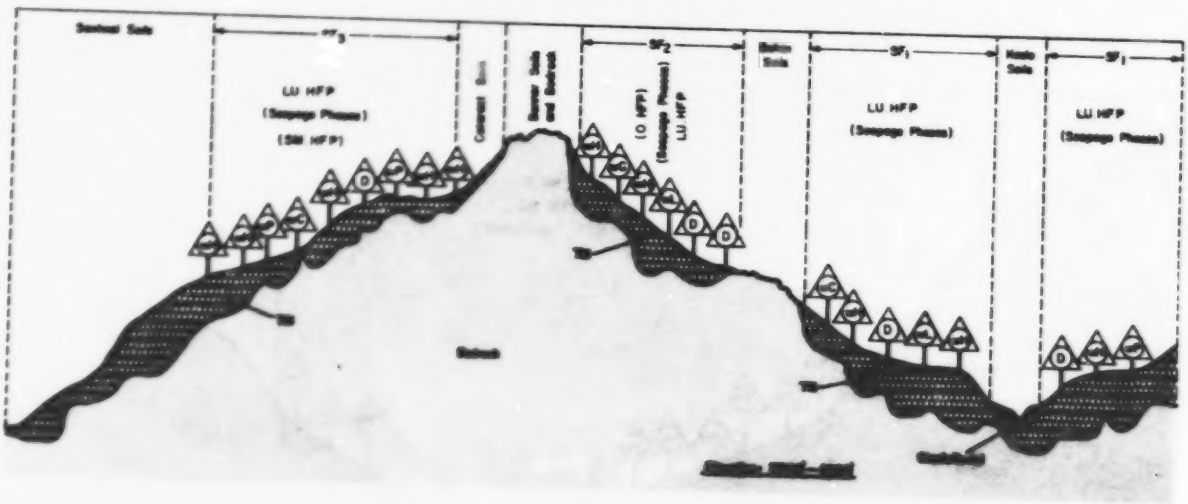


Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Sandner	SD1	Orthic Humo-Ferric Podzol	w	.....		medium to moderately fine textured glacial till	4500-5800	Subalpine Engelmann spruce - alpine fir
	SD2	Orthic Humo-Ferric Podzol	w	seepage phase	i			
	SD3	Orthic Humo-Ferric Podzol	w	Degraded Dystric Brunisol	w			
	SD4	Orthic Humo-Ferric Podzol	w	Degraded Dystric Brunisol seepage phases	w i			
	SD5	Orthic Humo-Ferric Podzol	w	Orthic Ferro-Humic Podzol seepage phases	w i			

STEENHOFF ASSOCIATION (SF)

The soils of the Steenhoff association are found in the vicinity of Meadow Creek, Lardeau and on mid-slope positions along either side of the Lardeau River valley at elevations between 3000 and about 4800 feet. The soil parent material is moderately to strongly sloping, medium to moderately fine-textured basal till. Soil textures range from loam to clay loam. The moderately stony till is similar to that of the Stubbs soils and overlies bedrock-controlled ridges with humps and depressions of various sizes. Steenhoff soils are well drained except in depressions and on some seepage sites where the drainage is imperfect.

The modal soil development is Luvisolic Humo-Ferric Podzol, characterized by moderately well developed clay-accumulation horizons in the lower solum. The solum is medium acid in reaction, and has a moderately high exchange capacity. Small amounts of volcanic ash are sometimes incorporated in the upper horizons. Significant soil inclusions are Orthic Humo-Ferric Podzols and Brunisolic Gray Luvisols, as well as seepage phases. Orthic Humo-Ferric Podzols lacking clay accumulation horizons occur where the parent material is coarser textured than usual. The Brunisolic Gray Luvisols are present at lower elevations where, because of lower rates of precipitation and slightly warmer temperatures, the podzolization process has not advanced sufficiently to produce podzolic Bf surface horizons.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Steenhoff	SF1	Luvisolic Humo-Ferric Podzol	w	seepage phase	i	medium to moderately fine textured basal till	3000-4800	Interior western hemlock - western red cedar
	SF2	Luvisolic Humo-Ferric Podzol	w	Orthic Humo-Ferric Podzol	w			
	SF3	Luvisolic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i			

Steenhoff Association (Cont'd)

The climate is somewhat influenced by the moderating effect of Kootenay Lake. Annual precipitation is about 25 to 45 inches and the frost-free period ranges between 120 and 150 days. Western hemlock, western red cedar, Douglas-fir with minor western larch and lodgepole pine form the tree canopy.

The land capability for forestry ranges from Class 2 to Class 1a. Large acreages with more level topography have been logged and some have limited agricultural potential.

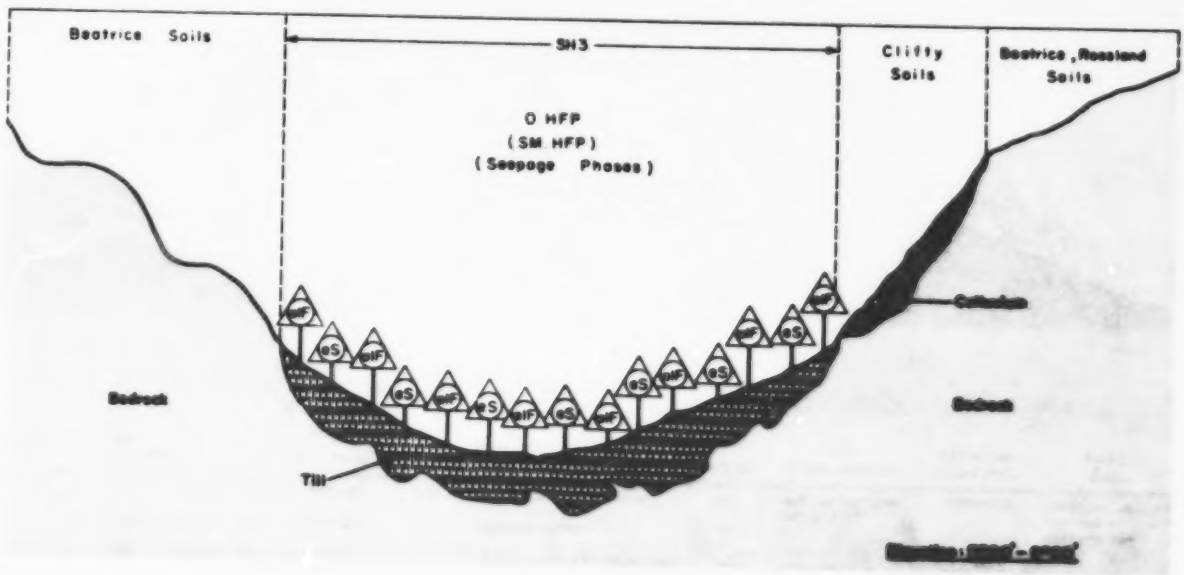
SWEHAW ASSOCIATION (SH)

A small acreage of Swehaw soils are mapped between Nakusp and Meadow Creek at elevations between 5500 and 6500 feet. The soils are found on upper mountain slopes, and in depressions and cirque basins that are covered by morainal deposits. The parent material consists of more than five feet of moderately coarse textured glacial till and some colluvium and contains many granitic and quartzitic stones and boulders. Typical soil textures are gravelly sandy loam or loam. Most Swehaw soils are well drained. Those present in swales and seepage channels are imperfectly drained.

The modal soil development is Orthic Humo-Ferric Podzol with significant inclusions of Sombric Humo-Ferric Podzols and associated seepage phases. These soils have very strong acidic reactions, and moderately low cation exchange capacities and base saturation.

The Swehaw association is characterized by short frost-free periods and moderately high precipitation with high snowfall in winter. The vegetation is typical of the upper Subalpine Engelmann spruce alpine fir forest zone. Alpine fir and Engelmann spruce are the dominant trees. Whitebark pine, lodgepole pine and mountain hemlock also occur in sheltered locations and are generally stunted and deformed.

Swehaw soils have very low capability for forest production and provide only limited natural grazing.

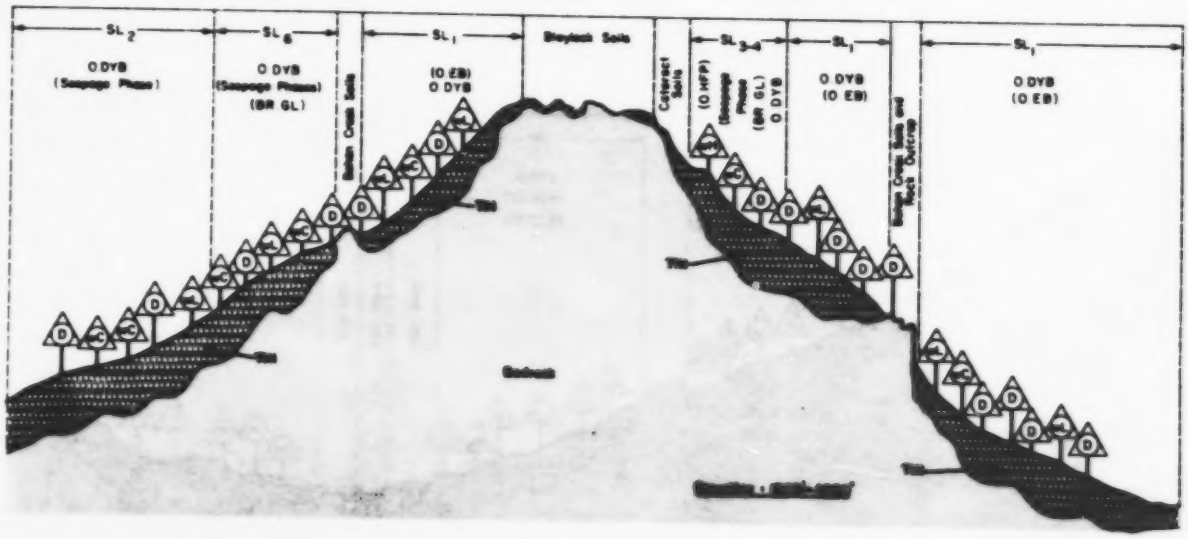


Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Swehaw	SH3	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol seepage phases	mw i	moderately coarse textured basal till	5500-6500	Subalpine Engelmann spruce - alpine fir

SENTINEL ASSOCIATION (SL)

Most Sentinel soils are found on the lower mountain slopes in the Arrow Lakes area. The soils have developed from medium-textured glacial till that is compact, hard and quite stony. This parent material occupies moderately to steeply sloping topography at elevations from 1500 to 4000 feet. The more steeply sloping topography generally occurs in the side valleys east of Arrow Lake.

The typical soils are well drained Orthic Dystric Brunisols. The soil reaction is strongly acid, the cation exchange capacities are moderately low and base saturation is medium to high. A variety of soil inclusions occur. Orthic Eutric Brunisols generally occur where the parent material is weakly to moderately calcareous. Orthic Humo-Ferric Podzols are present at higher elevations where podzolization is sufficiently advanced and Brunisolic Gray Luvisols have developed in areas of somewhat finer textures sufficient for Bt horizon formation. Associated imperfectly drained seepage phases occur with all soils and are specifically found as sideslope seepage above impervious basal till layers or



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Sentinel	SL1	Orthic Dystric Brunisol	w	Orthic Eutric Brunisol	w	medium textured basal till	1500-4000	Interior western hemlock - western red cedar
	SL2	Orthic Dystric Brunisol	w	seepage phase	i			
	SL3	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol	w			
				Brunisolic Gray Luvisol	w			
				seepage phases	i			
	SL4	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol	w			
				seepage phases	i			

Sentinel Association (Cont'd)

bedrock.

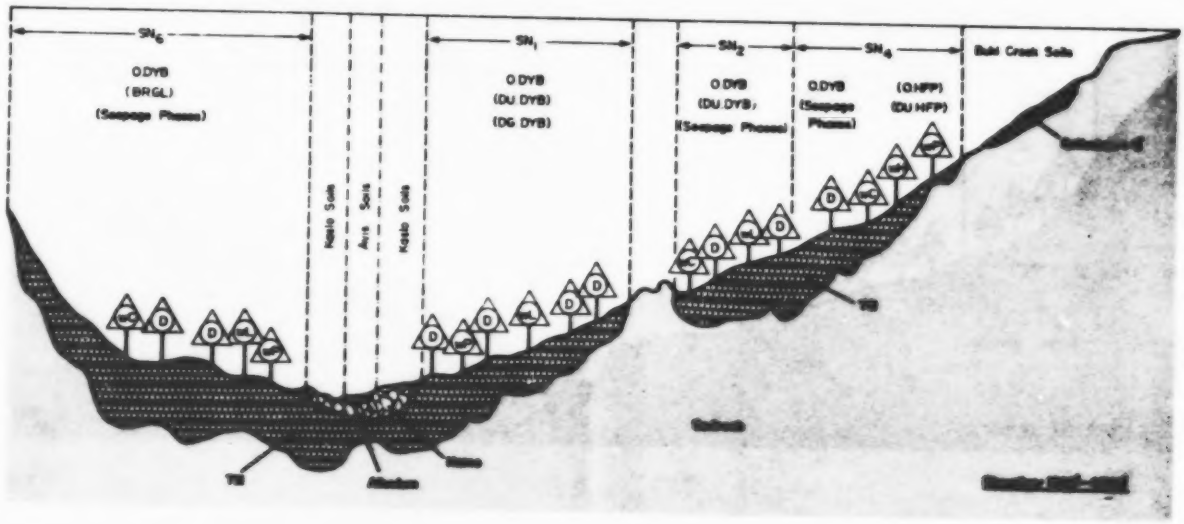
The climate associated with these soils is relatively warm and dry. The vegetation is primarily western hemlock, Douglas-fir, western larch and lodgepole pine, but western red cedar occurs in depressions and in seepage areas.

The land capability for forestry ranges from 90 to 150 cubic feet per acre per year. During the summer, soil moisture deficiency is the main limitation to forest growth. Some minor areas of Sentinel soils on more level topography have limited agricultural capability but soil moisture deficiency and stoniness generally limits their use to forage production.

SLOCAN ASSOCIATION (SN)

The soils of the Slocan Association are found near Lardeau and south of Nakusp. They occur on moderately steep mountain slopes covered by deep deposits of glacial till, at elevations ranging from 1500 to 4000 feet. The parent material is compact and moderately coarse textured. The upper solum had often been modified by colluvial action and is loose and permeable. Usual soil textures are gravelly sandy loam, sandy loam or gravelly loamy sand with variable contents of granitic stones.

Orthic Dystric Brunisol is the modal soil development. Soil reaction is strongly acid, the base saturation is moderately low and the cation exchange capacity is very low, partly as a result of the coarse textures within the profile. Significant soil inclusions are Duric Dystric Brunisols, Orthic and Duric Humo-Ferric Podzols, and Brunisolic Gray Luvisols. The Duric Dystric Brunisols and Duric Humo- Ferric Podzols have moderately cemented subsoil horizons. The Orthic Humo-Ferric Podzols occur at the higher elevations where Slocan soils grade into those of the Stobart Association. The Brunisolic Gray Luvisols have significant clay accumulation in the subsoil and occur in areas where the parent material is somewhat finer textured than usual.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Slocan	SN1	Orthic Dystric Brunisol	w	Duric Dystric Brunisol Degraded Dystric Brunisol	w w	moderately coarse textured basal till	1500-4000	Interior western hemlock - western red cedar
	SN2	Orthic Dystric Brunisol	w	Duric Dystric Brunisol seepage phases	w i			
	SN4	Orthic Dystric Brunisol	w	Orthic Humo-Ferric Podzol Duric Humo-Ferric Podzol seepage phases	w w i			

Slocan Association (Cont'd)

The environment is relatively warm and dry. The vegetative cover is composed of western hemlock and Douglas-fir, some western larch and some western red cedar in seepage and moisture accumulation areas. Buhl Creek and Cooper soils are often mapped in conjunction with the Slocan Association.

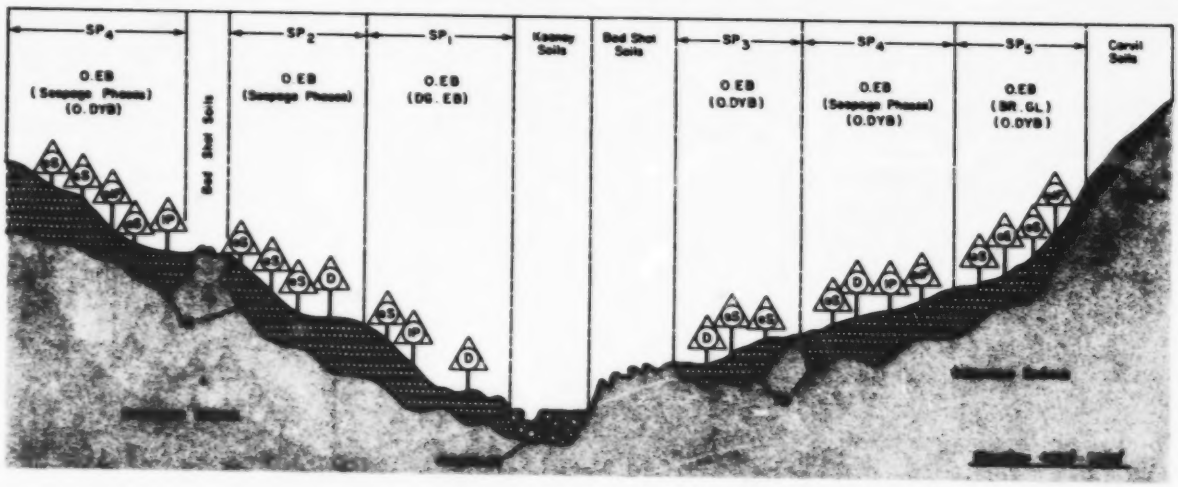
The land capability for forestry ranges from 90 to 130 cubic feet per acre per year with summer soil moisture deficiency as the main limitation. Adverse topography precludes agricultural use.

SPILLIMACHEEN ASSOCIATION (SP)

The Spillimacheen association is mapped in the eastern part of the map area adjacent to the Rocky Mountain Trench and in the Brisco Range at elevations of about 4500 to 5500 feet. The soils occur on moderately steep lower and middle mountain slopes covered by deep, calcareous, medium textured glacial till overlying calcareous bedrock. The upper 12 inches have often been influenced by colluvial processes. Generally, all stones and rock fragments are limestone or dolomite.

The modal soil development is Orthic Eutric Brunisol owing to the high lime content in the solum and parent material. Typical soil textures are gravelly silt loam or loam. Significant soil inclusions are Orthic Dystric Brunisols and Brunisolic Gray Luvisols. The former generally occur at the higher elevations and are due to higher rates of leaching, while the latter occurs on somewhat finer-than-usual-textured deposits where perceptible clay accumulation is present in the solum. Although Spillimacheen soils are generally well drained, some seepage phases do occur, and these are imperfectly drained.

Spillimacheen soils have developed in a cool and generally dry environment (May to September precipitation is less than 10 inches and frost-free



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Spillimacheen	SP1	Orthic Eutric Brunisol	w	Degraded Eutric Brunisol	w	medium textured, calcareous basal till	4500-5500	Subalpine Engelmann spruce - alpine fir
	SP2	Orthic Eutric Brunisol	w	seepage phase	i			
	SP3	Orthic Eutric Brunisol	w	Orthic Dystric Brunisol	w			
	SP4	Orthic Eutric Brunisol	w	Orthic Dystric Brunisol seepage phases	w i			
	SP5	Orthic Eutric Brunisol	w	Brunisolic Gray Luvisol Orthic Dystric Brunisol	w w			

period is less than 60 days). The climatic conditions are typical of the Subalpine Engelmann spruce-alpine fir zone. Lodgepole pine and minor amounts of Douglas-fir are also present.

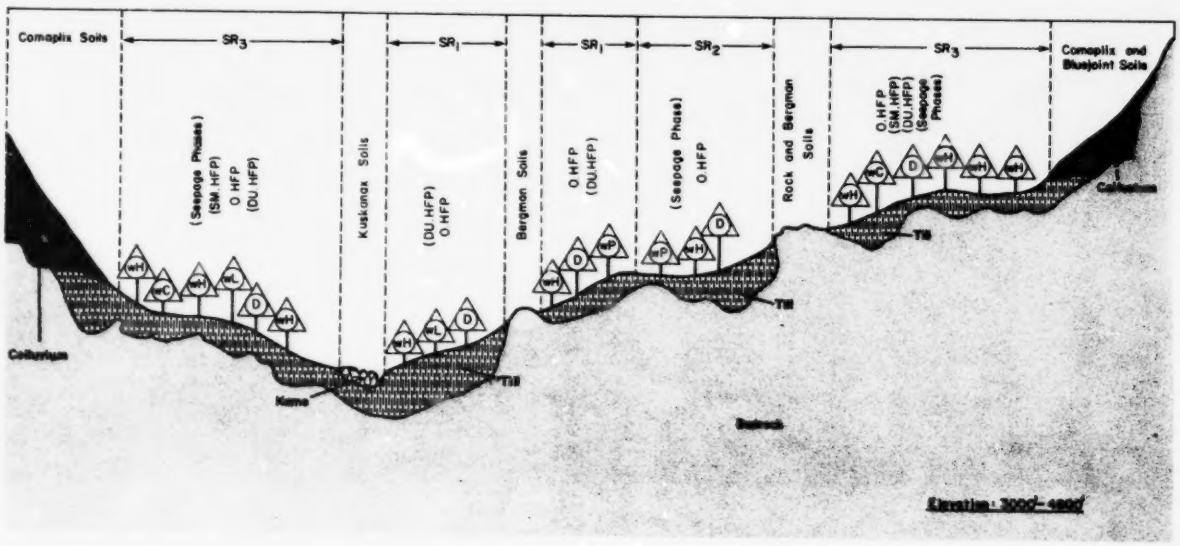
The mean annual increments for wood growth range from 50 to 90 cubic feet per acre per year for Engelmann spruce and limited logging has occurred. The soils are unsuitable for agriculture because of cool temperatures, short frost-free periods, stoniness and steep topography.

STOBART ASSOCIATION (SR)

Stobart soils occur on the east side of Upper Arrow Lake between elevations of 3000 and 4800 feet on steeply sloping middle mountain slopes covered by deep glacial till. The parent material is coarse to moderately coarse textured and contains a high proportion of coarse-grained rock fragments such as quartz, granodiorite and granite. Soil textures are primarily gravelly loamy sand or gravelly sandy loam. The subsoil is usually quite compact. The uppermost foot is loose and permeable and is often slightly coarser textured and may contain more stones than the underlying subsoil.

The modal soils are well-drained Orthic Humo-Ferric Podzols. They have very strongly acid sola and medium acid parent materials. The base saturation is low in the solum but increases with depth because of a general increase in pH. The cation exchange capacity is low. A few areas have deeper Bhf horizon and are classified Orthic Ferro-Humic Podzols. Significant soil inclusions are Sombric Humo-Ferric Podzols and Duric Humo-Ferric Podzols. The former occurs in seepage and depressional areas which are moister than the usual, and the latter are prevalent on more level topography where moderately cemented horizons occur in the subsoil.

The environment is moist and cool. The forest cover consists primarily of mature and overmature western hemlock. Western red cedar often occurs on seepage sites. Above about 4500 feet elevation,



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Stobart	SR1	Orthic Humo-Ferric Podzol	w	Duric Humo-Ferric Podzol	w	coarse to moderately coarse textured basal till	3000-4800	Interior western hemlock - western red cedar
	SR2	Orthic Humo-Ferric Podzol	w	seepage phase	i			
	SR3	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol	mw			
				Duric Humo-Ferric Podzol	w			
				seepage phases	i			

mixed stands of western hemlock and Engelmann spruce are found and above 5000 feet Engelmann spruce becomes dominant. Associated soils are Comaplix and Bergman associations.

Stobart soils are generally densely tree covered and have excellent forest capabilities which range from Class 2 to Class 1a for western hemlock and Douglas-fir. Because of adverse topography and climate, Stobart soils are unsuitable for agricultural production.

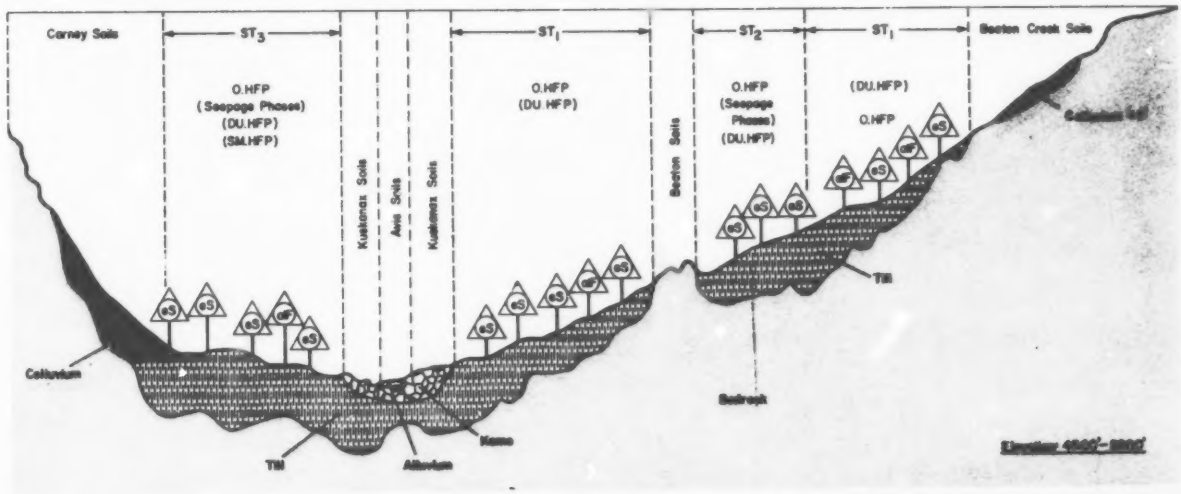
ST. LEON ASSOCIATION (ST)

The St. Leon soil association occurs throughout the Slocan Mountains in the western half of the map area at elevations between 4500 to 5800 feet. The soils occur on steep upper mountain slopes and rolling upland plateaus. The parent material is medium textured (gravelly loam, gravelly silt loam or gravelly clay loam), stony, compact glacial till. The surface has often been modified by colluvial action.

Typical well drained soil development is Orthic Humo-Ferric Podzol with significant inclusions of Duric and Sombric Humo-Ferric Podzols. The soils are strongly acid with low base saturations and have moderately low cation exchange capacities. Sombric Humo-Ferric Podzols occur in and near seepage sites. Duric Humo-Ferric Podzols commonly occur on the more level topographic areas and have moderately cemented subsoil layers.

The St. Leon soil association has developed in a moist and cool climate (less than 15 inches May to September precipitation and fewer than 90 frost-free days). The tree cover is Engelmann spruce and alpine fir.

Land capability for forestry ranges from Class 1 to Class 2; cold temperature is the main limiting factor. St. Leon soils are unsuitable for agriculture primarily because of the short frost-free period and adverse topography.

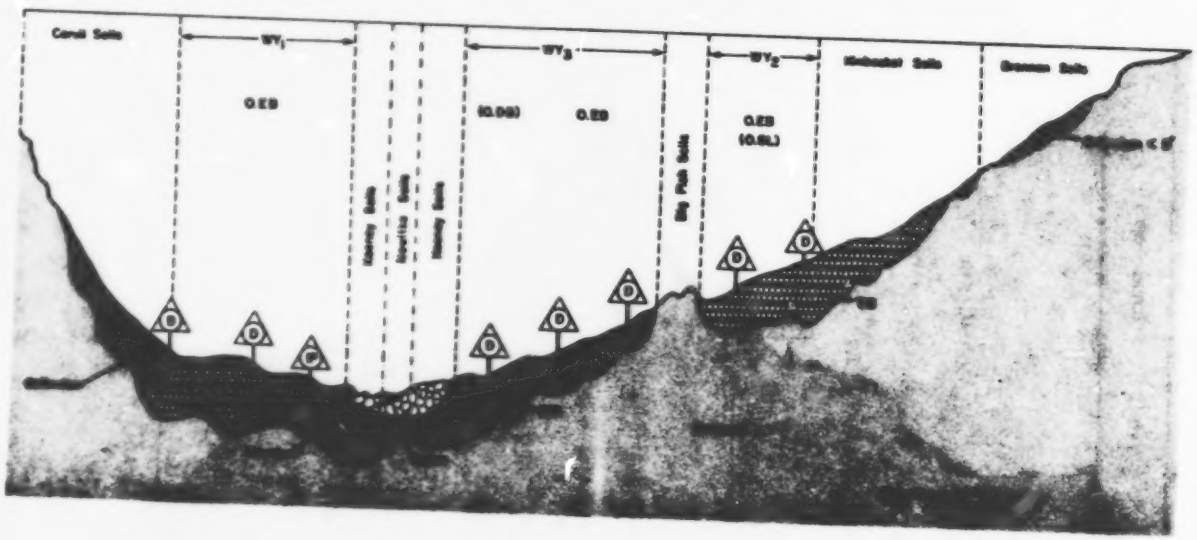


Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
St. Leon	ST1	Orthic Humo-Ferric Podzol	w	Duric Humo-Ferric Podzol	w	medium to moderately fine textured basal till	4500-5800	Subalpine Engelmann spruce - alpine fir
	ST2	Orthic Humo-Ferric Podzol	w	Duric Humo-Ferric Podzol seepage phases	w i			
	ST3	Orthic Humo-Ferric Podzol	w	Sombric Humo-Ferric Podzol Duric Humo-Ferric Podzol seepage phases	rw w i			

WYCLIFFE ASSOCIATION (WY)

Wycliffe soils occur in the southeastern portion of the map area, mainly in the Rocky Mountain Trench and in the valleys of Findlay, Doctor, Ditch and Toby creeks. Elevations range from 2600 to about 3500 feet. These soils have developed on rolling, hummocky and drumlinized glacial till in the Rocky Mountain Trench and on strongly sloping, glacial till covered, lower mountain slopes in adjacent valleys. The glacial till is usually moderately to strongly calcareous. In the Rocky Mountain Trench the till is usually covered with a thin veneer of wind-blown material. Silt loam or sandy loam, with occasional loam and clay loam, are the common textures in the lower solum and parent material, whereas very fine sandy loam is usual at or near the surface. Wycliffe soils are usually well drained.

Typical soil development is Orthic Eutric Brunisol. Strong to very strong alkaline reactions usually prevail throughout the profile. Lime accumulation layers are often found at depths of only three to six inches from the soil surface. Cation exchange capacities are moderate to very low. Significant soil inclusions are Orthic Gray Luvisols and Orthic Dark Browns. The former occur in areas where the parent material is relatively less alkaline, with slightly higher rates of precipitation and clay contents and grade to the Kinbasket association. The Orthic Dark Brown soils occur in the grassland areas and are associated with Wycliffe soils.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Wycliffe	WY1	Orthic Eutric Brunisol	w	.....		moderately coarse to medium textured calcareous basal till	2600-3500	Interior Douglas-fir
	WY2	Orthic Eutric Brunisol	w	Orthic Gray Luvisol	w			
	WY3	Orthic Eutric Brunisol	w	Orthic Dark Brown	w			

The climate is moderately cool and dry. Douglas-fir is the dominant tree species, but there are lesser amounts of lodgepole pine, trembling aspen, and ponderosa pine. Numerous open park-like areas have a ground cover of junipers and grasses composed of bluebunch wheat grass, Idaho fescue and pinegrass.

Most of these soils are still uncleared and support second-growth Douglas-fir stands. Land capabilities for forestry range from Class 4 to Class 6, with droughtiness and exposure being the main limitations. The soils are moderately suitable for low carrying capacity natural grazing. The agricultural capability is low, ranging from Class 4 to Class 6, if irrigated. Stoniness and adverse topography are the main limitations.

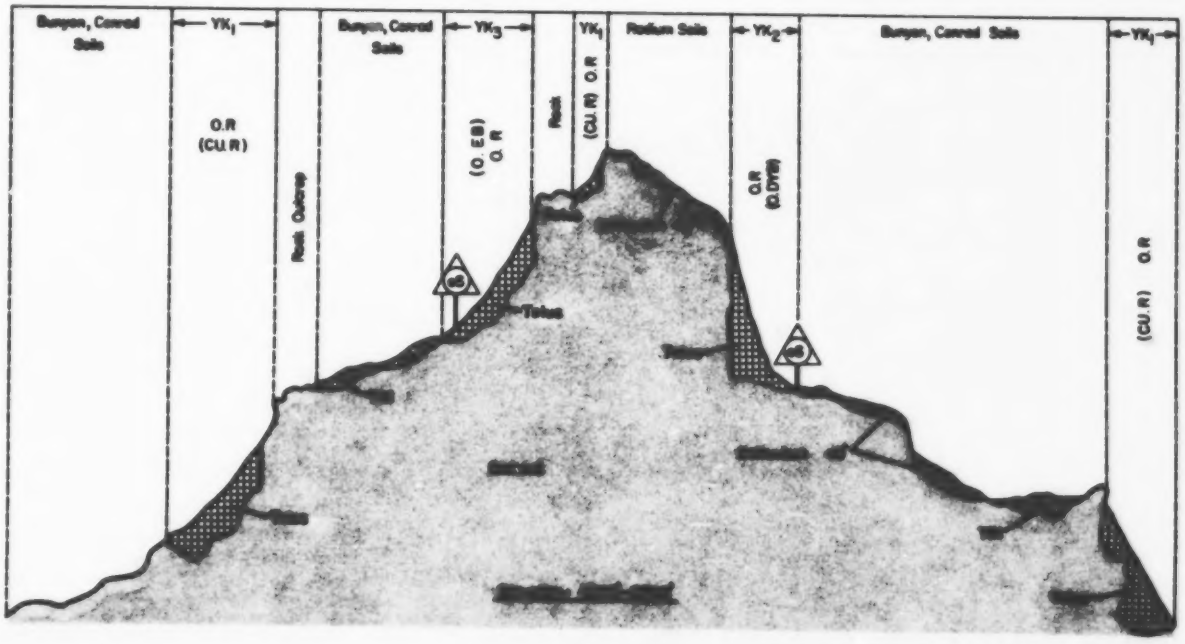
YAHK CREEK ASSOCIATION (YK)

Yahk Creek soils occur in the eastern half of the map area on steep, non-vegetated slopes at upper elevations in the Subalpine Engelmann spruce-alpine fir forest zone. Elevations range from 4500 to 8500 feet.

The landform is typically talus and very steep. The soil parent material is very coarse textured, usually calcareous, with many angular boulders. Limestone or dolomite are often the dominant components of the talus. Boulders and other large fragments are usually found on the aprons at the base of the steep slopes or bluffs, whereas the smaller sized and finer textured material is present at slightly higher elevations near the apex.

The typical soil development is Orthic Regosol. The instability of slopes together with their potentially dangerous state and periodic additions by mass wasting from higher elevations, usually provide little opportunity for vegetation or soil horizons to develop. In a few areas which have stabilized, weakly developed Orthic Eutric or Orthic Dystric Brunisols are present.

Yahk Creek soils are unsuitable for either agriculture or forestry. Wildlife browsing is not common due to the absence of deciduous browse species.



Soil Association Name	Soil Assn. Component	Dominant Soil Subgroups	Drainage	Significant Soil Subgroup(s) or Phase(s)	Drainage	Soil Parent Material	Elevation Range(feet)	Forest Zone
Yahk Creek	YK1	Orthic Regosol	w,r	Cumulic Regosol	w	loose, stony and bouldery talus	4500-8500	Subalpine Engelmann spruce - alpine fir
	YK2	Orthic Regosol	w,r	Orthic Dystric Brunisol	w			
	YK3	Orthic Regosol	w,r	Orthic Eutric Brunisol				

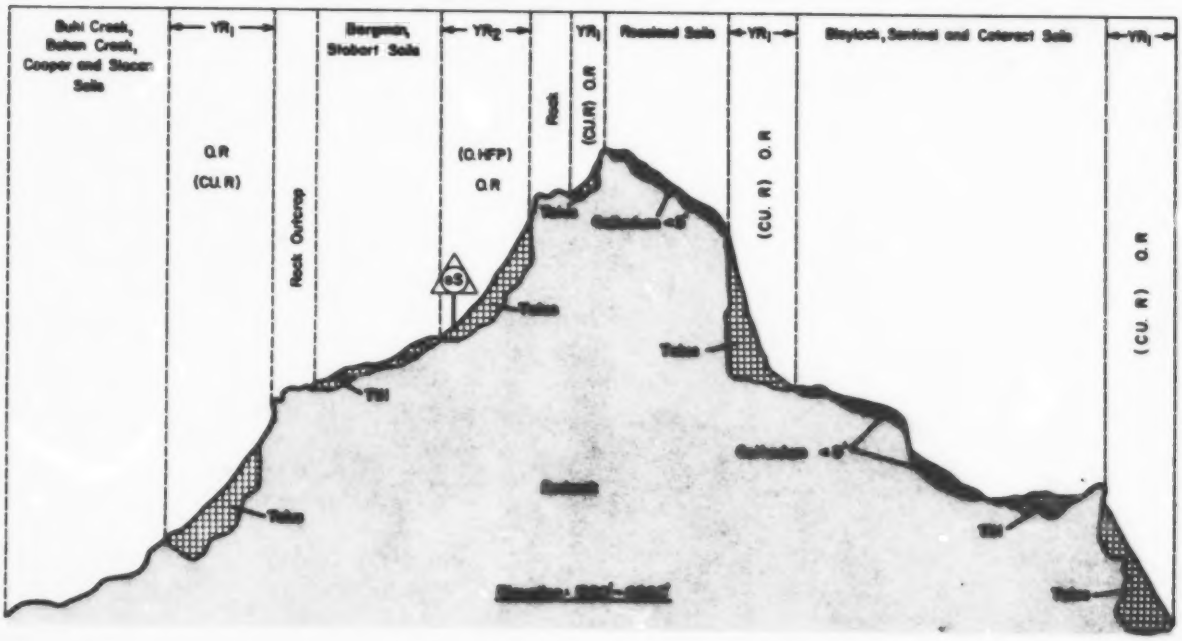
YMIR ASSOCIATION (YR)

Ymir soils occur throughout the western half of the map area at elevations ranging from 1500 to 6800 feet.

These soils are found on non-vegetated, very steeply sloping colluvial deposits (talus) which have accumulated at the base of steep slopes and cliffs. The soils are typically permeable and coarse textured with large proportions of angular stones and boulders. Generally, the larger-size components are found near the toe of the slopes and the finer materials closer to the apex. The rock fragments are generally medium and coarse grained and are composed of granites, granodiorites, argillites and schists. Calcareous rock fragments are generally absent.

Most soil profiles, especially those in actively accumulating areas, are Orthic Regosols. Inclusions of Orthic Humo-Ferric Podzols occur where relative stability has taken place.

Most Ymir soils are non-vegetated and usually occur at the upper elevations near timberline. They are unsuitable for both agriculture and forestry mostly due to the instability of the landscape and steep terrain. The soils do not support plant species suitable for wildlife browsing.


Buhl Creek, Buhan Creek, Cooper and Slocan Soils
YR1
Bergman, Slobert Soils
YR2
YR1
Rossland Soils
YR1
Blaylock, Sentinel and Colerest Soils
YR1
Rock Outcrop
Rock
(CU.R) O.R
(CU.R) O.R
(CU.R) O.R
(CU.R) O.R
(O.HFP) O.R
Talus
Talus
Talus

MISCELLANEOUS LAND TYPES

Rock (RO) — The Rock landtype consists of areas which have less than four inches of soil over bedrock or the bedrock is exposed. It occupies scattered areas at the lower elevations but becomes dominant above the alpine tundra zone.

Moraine (M) — The Moraine landtype consists of recent, glacier deposited materials. It is bouldery and cobbly and usually gravelly sandy loam textured and occurs in immediate association with the present glaciers in the map area. It has Orthic Regosol soil development and vegetation is generally absent.

Glacier Ice (I) — The Glacier Ice landtype consists of present glaciers and permanent snowfields.

Water (WW) — The Water landtype consists of areas of intermittent water bodies.

Organic Deposits(O) — The Organic Deposits landtype consists of minor areas of poorly drained accumulations of organic material. Decomposition is variable and depths are usually greater than 20 inches.

chapter four

SOIL INTERPRETATIONS

SOIL INTERPRETATIONS

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4 SOIL INTERPRETATIONS

Soil interpretations relate soil, landscape and/or climate characteristics to a specified use on the basis of their suitabilities (or limitations) for that use. The main purpose in compiling interpretive material is to present information in a form that is more easily understood than the basic soil or landscape data.

Soil interpretations are predictions about the behaviour of soils under specific uses. They usually pertain to the soil and landscape as a whole and not to the individual properties and qualities such as texture and permeability. The interaction and sum of all the soil's properties and qualities determines its behaviour and its limitations for use. The predictive ratings are intended to inform the planning process as general land use recommendations; they are not intended as site specific recommendations for land use.

4.1 SOIL INTERPRETATIONS FOR ENGINEERING

Among soil properties highly pertinent to engineering are soil strength, compaction characteristics, permeability, soil drainage, grain size distribution, shrink-swell potential, plasticity and soil reaction. Also important are depth to bedrock, depth to water table and slope. These properties, in varying degrees and combinations, affect construction and maintenance of roads, pipelines, foundations for small buildings, irrigation systems, small dams and systems for disposal of refuse and sewage. Interpretations for some of these uses are presented in this report.

Such information, however, does not eliminate the need for further site-specific investigations and is not intended to take its place. For the engineer, knowledge of the general setting of an area is of primary importance before beginning detailed site investigations. This general approach is also important for a pedological survey, so that one may better understand the soil and the landscape and make better predictions about their response to various uses.

Some of the terms used in this soil survey have special meaning in soil science that may not be familiar to engineers. Most of the terms commonly used in soil science are defined in the glossary.

4.11 SOIL PROPERTIES SIGNIFICANT IN ENGINEERING

Engineering test data is provided for some of the major surficial deposits of the Lardeau map area. These are given in Table 2. The samples were taken at depths varying from three to 18 feet and are representative of some of the dominant soil parent materials. The following sections explain some of the columns in Table 2.

4.111 The sieve analyses

These values were determined on the whole soil sample by passing it through the U.S. Bureau of Standard Sieves: 3 inches, 2 inches, 1 1/2 inches, 1 inch, 3/4 inch, 3/8 inch, .187 inch, and numbers 10, 20, 40, 60, 140 and 200 sieves. An accumulation curve was compiled and the percent of material passing the #4, 10, 40 and 200 sieve was noted. These figures were used to classify the soil sample into the various textural classifications according to their particle size and other characteristics. For some classification systems, the Atterberg Limits were also noted. (Field Manual of Soil Engineering, 1970).

4.112 Soil moisture retention

The water (in percent) that is retained when the soil is subjected to 0.1, 0.33, 1.0 and 15.0 bars presssure (soil moisture tension) are among the most important physical characteristics affecting the use of soils.

4.113 Atterberg Limits

The engineering properties of soil vary with

Table 2: Engineering test data for some soils of the Lardeau map area

TYPE OF ANALYSIS					SIEVE ANALYSIS (% PASSING FOLLOWING SIEVE SIZE) (ALL PASSING 3" SIEVE)												MOISTURE CONSTANTS (% H_2O) (40 MESH SOIL)				ATTERBERG LIMITS (% WATER)				CLASSIFICATION SYSTEMS		
PARENT MATERIAL	SOIL ASSOCIATION	LOCATION	DEPTH SAMPLE (FEET)	CONDUCTIVITY (mmho/cm²)	2"	11/2"	1"	3/4"	3/8"	.187"	#10	#20	#40	#60	#140	#200	0.10 BAR	0.33 BAR	1.0 BAR	15.0 BAR	LL	PL	SL	PI	AASHO	UNIFIED	USDA
GLACIAL TILL	Kinbasket Association	50° 37'40"N; 116° 8'20"W	6'	2.3	100	97.2	95.43	90.20	88.92	78.42	67.41	45.38	32.91	31.01	26.13	25	22.2	19.7	14.6	5.3	16.08	14.55	13.78	1.53	A-1-b	SM	gSL-gSCL
	Kinbasket Association	50° 37'25"N; 116° 10'40"W	6'		100	100	98.84	95.63	87.77	68.29	53.74	24.63	14.89	13.98	11.72	11.21	24.2	21.7	17.8	6.5	20.95	17.28	3.35	3.67	A-1-b	SW-SM	gSL-gLS
	Wycliffe Association	50° 34'20"N; 116° 5'30"W	5'	4.5	96.77	87.61	82.59	77.35	68.58	64.18	56.51	41.17	29.04	25.50	18.41	17.19	19.9	16.3	12.3	4.4	15.60	13.67	10.83	1.93	A-1-b	SM	gSL
	Wycliffe Association	50° 33'15"N; 116° 4'25"W	14'		100	100	97.52	92.66	82.94	75.54	58.37	24.03	13.29	11.32	8.53	8.08	16.7	14.9	12.7	7.2	16.34	12.07	10.58	4.28	A-1-b	SW-SM	gSL
	Wycliffe Association	50° 29' 0"N; 116° 1'50"W	11'		100	94.77	91.05	85.72	77.02	70.18	63.62	30.51	16.25	15.17	12.81	12.35	19.8	17.6	14.6	6.7	17.04	13.57	12.70	3.47	A-1-b	SM-SC	gSL
	Wycliffe Association	50° 8'20"N; 116° 1'25"W	4'	0.4	100	99.73	97.29	95.75	89.31	84.17	80.03	64.12	51.82	50.37	47.74	47.12					21.10	19.36		1.74	A-4	ML-CL	L-CL
	Spillimacheen Association	50° 30'30"N; 115° 56'40"W	8'		100	100	98.95	94.82	73.91	44.20	24.55	12.25	7.94	7.29	6.29	6.03	26.1	22.2	20.2	15.1	25.56	17.76	13.93	7.80	A-1-a	GW-GM	vgSL
	Sentinel Association	50° 15'25"N; 116° 59' 0"W	10'	1.3	100	100	98.80	98.32	94.88	91.39	84.28	47.98	31.84	30.49	27.15	26.18	25.9	21.2	15.2	6.4	19.63	15.78	15.48	3.84	A-1-b	SM-SC	SL
	Sentinel Association	50° 16'45"N; 117° 0'40"W	4'	0.2	100	98.47	94.51	89.34	78.94	66.60	50.88	37.87	29.02	25.35	18.81	17.35	24.7	16.6	10.3	3.3	NP	NP	NP	NP	A-1-b	SM	vgSL
	Sentinel Association	50° 39' 0"N; 117° 49'20"W	14'	0.3	100	96.53	89.69	83.92	73.73	62.81	50.03	39.10	30.88	27.53	21.06	19.71	26.7	19.9	13.1	4.0	NP	NP	NP	NP	A-1-a	SM	vgSL
	Stubbs Association	50° 15'35"N; 117° 2'35"W	12'	0.2	100	100	89.94	84.53	75.19	65.68	59.44	40.88	30.90	28.12	22.51	21.18	34.2	24.2	15.3	3.7	22.92	20.72	18.69	2.20	A-1-b	SC	gSL
	Stubbs Association	50° 39'30"N; 117° 59'55"W	5'		100	95.14	86.91	78.89	68.38	57.92	42.56	30.11	21.41	16.96	11.12	10.55	21.6	14.6	11.1	5.4	NP	NP	NP	NP	A-1-a	SW-SM	vgSL
	Stubbs Association	50° 47'25"N; 117° 38' 0"W	12'		97.46	94.71	88.83	80.53	64.81	51.93	37.72	22.46	12.90	7.91	4.90	4.56	25.2	20.4	15.8	5.4	NP	NP	NP	NP	A-1-a	GW	vgLS-gS
	Stubbs Association	50° 34'20"N; 117° 23'15"W	15'	0.8	100	100	99.35	97.78	88.51	76.79	54.29	35.20	24.82	22.71	18.71	17.73	23.9	21.1	17.9	5.0	18.46	14.07	12.54	4.39	A-1-b	SC	gSL-gSCL
	Stubbs Association	50° 46'10"N; 117° 46'30"W	7'	0.3	100	100	97.59	94.29	88.19	81.78	50.30	35.12	23.57	21.96	19.01	18.40	26.0	22.7	18.0	7.5	21.50	16.61	14.87	4.89	A-1-b	SC	gSL
	Stobart Association	50° 29'45"N; 117° 50'30"W	12'	0.2	100	100	100	100	98.43	96.13	93.53	63.11	48.49	46.05	34.80	33.22	22.6	15.2	10.2	4.7	13.60	12.55	11.01	1.05	A-2	SM	SL
	Stobart Association	50° 33'25"N; 117° 53'15"W	18'	0.2	100	100	99.61	97.03	89.78	82.59	75.00	42.90	29.22	27.36	20.91	20.05	22.5	16.3	11.9	6.4	15.34	13.34	12.55	2.00	A-1-b	SM	gSL-gLS
	Stobart Association	50° 24'40"N; 117° 7'30"W	7'	0.3	100	98.44	94.86	92.16	84.04	74.96	61.37	39.11	20.81	13.24	8.61	7.79	19.7	15.2	11.5	3.1	NP	NP	NP	NP	A-1-b	SW-SM	gLS-gS
	Stobart Association	50° 14' 0"N; 117° 38'15"W	3'		100	98.33	96.23	92.81	86.41	60.31	73.47	63.17	52.74	43.67	28.03	24.70					NP	NP	NP	NP	A-2	SM	gSL
	Steenhoff Association	50° 14'30"N; 117° 1'15"W	8'		100	100	97.74	96.87	93.86	90.60	81.08	48.63	33.95	31.65	29.56	28.50	32.0	27.3	20.3	7.8	24.79	19.22	18.60	5.57	A-1-2	SC	SCL-SL
	Slocan Association	50° 17'25"N; 117° 44' 0"W	8'	0.2	100	100	97.31	95.91	92.39	89.32	84.45	66.79	55.51	48.33	33.86	25.11	20.8	11.1	5.9	1.5	23.51	17.29	17.09	6.22	A-2-4	SC	SCL-SL
GRAVELLY OUTWASH	Keeney Association	50° 36'30"N; 116° 8'25"W	6'		100	96.66	93.62	90.49	75.82	52.68	44.61	28.47	17.86	12.70	6.84	6.14	15.7	13.8	11.2	3.0	NP	NP	NP	NP	A-1-a	GW-GM	vgLS
	Keeney Association	50° 38'45"N; 116° 12'40"W	5'		97.03	86.15	79.10	72.51	57.74	40.50	30.07	20.86	14.24	10.55	8.12	7.54	30.3	21.4	12.8	4.9	26.67	23.58	22.91	3.09	A-1-a	GW-GM	SL
SANDY OUTWASH	Gillis Association	50° 13' 0"N; 117° 57'35"W	3'		100	100	100	100	100	99.93	99.53	99.50	97.66	79.49	14.77	9.26	7.3	4.0	3.3	1.8	NP	NP	NP	NP	A-3	SW-SM	S
	Gillis Association	50° 15'50"N; 118° 1'25"W	3'		100	100	100	100	100	100	98.95	94.67	89.17	84.68	59.85	53.65	25.2	14.2	9.2	2.7	NP	NP	NP	NP	A-4	ML	L-SiL
RECENT FLUVIAL DEPOSITS	Nowitka Association	50° 34'25"N; 116° 18'20"W	4'		100	100	100	100	100	99.95	99.91	99.82	98.61	90.52	47.36	37.32	18.1	9.6	4.7	1.8	NP	NP	NP	NP	A-4	SM	SL-SCL
	Nowitka Association	50° 37'20"N; 116° 6' 5"W	5'		100	100	100	100	100	99.98	99.96	99.95	99.89	99.37	85.42	63.61	33.5	10.2	5.1	1.9	NP	NP	NP	NP	A-4	ML	SiL
	Avis Association	50° 13' 0"N; 116° 57'10"W	4'		100	100	100	100	100	100	98.92	92.09	83.18	82.95	81.84	81.56	54.2	49.0	22.2	4.9	29.95	21.06		18.89	A-4	CL	SiL-SiCL
LACUSTRINE SEDIMENTS	Mayook Association	50° 27' 5"N; 116° 0'25"W	12'		100	100	100	99.09	76.09	50.4	24.78	12.15	7.43	7.40	7.22	7.20	40.7	39.7	33.3	11.2	33.0	22.83		10.17	A-1-aA4	GW-GM	SL
	Mayook Association	50° 30'45"N; 116° 0'40"W	7'		100	100	100	100	100	98.1	95.28	79.15	67.86	66.54	63.43	61.09	28.6	27.4	14.3	3.3	NP	NP	NP	NP	A-4	SM	SiL
	Mayook Association	50° 8'10"N; 116° 1' 5"W	3'		100	100	100	100	100	100	100	92.92	91.33	91.08	69.72	63.39					NP	NP	NP	NP	A-4	SM	SiL
	Mayook Association	50° 8' 5"N; 116° 1' 5"W	3'		100	100	100	100	100	99.79	99.03	98.89	98.74	98.64	98.36	98.25					24.80	21.65		3.15	A-4	CL	SiCL
	Lawley Association	50° 6'40"N; 117° 57' 0"W	4'		100	100	100	100	100	100	99.03	48.36	28.16	27.99	27.23	27.00	52.2	43.7	38.0	25.0	61.11	34.05	21.68	27.06	A-7	SC	SCL
	Lawley Association	50° 8'35"N; 117° 48' 0"W	8'		100	100	100	100	100	100	100	100	100	99.98	99.95	99.93	45.2	45.1	19.9	5.0	32.14	24.00		8.14	A-4	CL	SiCL
DEEP COLLUVIUM	Couldron Association	50° 34'45"N; 116° 18' 0"W	5'	0.7	100	97.23	90.02	83.97	75.16	64.3	53.61	39.58	30.43	27.51	22.27	21.06	26.1	23.6	17.8	4.2	20.30	18.10	17.74	2.20	A-1-b	SM	gSL
	Cervil Association	50° 30' 0"N; 115° 56'40"W	6'	0.5	100	100	100	99.72	99.49	98.2	96.56	89.08	82.55	79.87	75.78	74.00	39.5	26.2	12.2	4.8	NP	NP	NP	NP	A-4	SM	SiL
	Cataract Association	49° 58'40"N; 117° 11'30"W	7'		100	88.65	82.43	74.67	56.29	44.81	36.59	26.86	21.13	19.21	15.67	14.09	28.4	21.9	12.8	4.5	19.89	18.59		1.30	A-1-a	GM	vgSL
	Calamity Association	50° 3' 0"N; 116° 55' 0"W	10'	0.3	100	100	99.47	98.53	97.26	93.84	79.78	59.34	46.63	44.84	35.86	34.86	25.5	19.9	15.3	5.8	18.70	16.18	15.65	2.52	A-1A-2	SM-SC	gSL-gL
SHALLOW COLLUVIUM	Beaton Association	50° 36'50"N; 117° 59'45"W	5'	0.15	100	100	98.17	96.97	92.50	86.76	76.54	46.96	32.21	26.99	19.50	17.86	24.7	17.6	14.0	6.7	NP	NP	NP	NP	A-1-b	SM	gLS
	Radium Association	50° 20'30"N; 116° 12'50"W	3'		100	92.81	84.49	79.75	72.76	67.94	61.31	50.99	46.47	42.24	30.37	28.19					24.97	22.17		2.80	A-1-b	SM	gSL-gL

the amount of water present. Atterberg Limits measure the effect of moisture on the consistence of the soil material and arbitrarily differentiate between its various states.

a) The liquid limit is the minimum moisture content at which the soil-water mixture changes from a liquid to a plastic state, and represents the moisture content at which the soil will barely flow under an applied force.
b) The plastic limit is the minimum moisture content at which the soil-water mixture changes from a plastic to a semi-solid state. It represents the minimum moisture at which puddling is possible and the maximum moisture content at which the soil is friable. It also generally indicates the point of maximum cohesion in the soil.
c) The plastic index is the arithmetic difference between the liquid and plastic limits and indicates the range of moisture content within which a soil material is in a plastic condition. Generally the greater the plasticity index, the greater are the plasticity, compressibility and volumetric change characteristics of the soil.
d) The shrinkage limit is the moisture content at which soil changes from a semi-solid to a solid state. Beyond this point, further reduction in the moisture content is not accompanied by a change in volume.

Atterberg limits are most commonly applied in the planning of road construction. Generally, soils with high liquid limits, such as clays, have poor engineering properties. A low plasticity index, on the other hand, indicates a granular soil with little or no cohesion or plasticity. Some silts and sandy soils are non-plastic (NP).

4.114 Textural Classification Systems

a) American Association of State Highway Officials (AASHO) System

The AASHO system is based on the observed field performance of soils under highway pavement: it is widely known and used by highway engineers. In this system a soil is placed in one of seven basic group ratings (A-1 to A-7) on the basis of grain size distribution, liquid limit and plasticity index as shown in Table 15 (Appendix). Group A-1 are gravelly soils of high bearing strength and are the best soils for subgrade. In contrast, clay soils having low bearing strength when wet, are the poorest soils for subgrade. (Asphalt Institute, 1969).

b) The Unified System

This system is based on the plasticity-compressibility characteristics of soils and illustrates how fines affect liquid and plastic limits. In coarse-grained soils, the percentages of gravel, sand and fines as well as the shape of the grain-size distribution curve forms the basis of soil properties identification. A soil is given a descriptive name and letter symbol to indicate its principal characteristics. The characteristics of the 15 classes are found in Table 3. Eight of these classes are coarse-grained and identified as GW, GP, GM, GC, SW, SP, SM and SC. Fine-grained classes are identified as ML, CL, OL, MH, CH and OH. One class of organic soil is identified as P-1 (Asphalt Institute, 1969).

c) The U.S. Department of Agriculture System

This system is used for pedological soil classification and for agricultural soil texture interpretations. In this system, soil texture refers to the amounts of sand, silt and clay making up the soil mass. The following soil texture diagram (Figure 16) shows the various textural class abbreviations and limits for each class. The presence of gravel is indicated by adding the prefix "gravelly" or "very gravelly" to the soil texture class. "Gravelly" is used when 20-50% of the soil volume consists of particles between 2 and

75 mm in size and "very gravelly" is used when the volume is between 50 and 90% (Canada Department of Agriculture, 1972).

Figure 17 shows particle size limits for each system and also indicates how they relate to each other (Smith, R.E. et al, 1975).

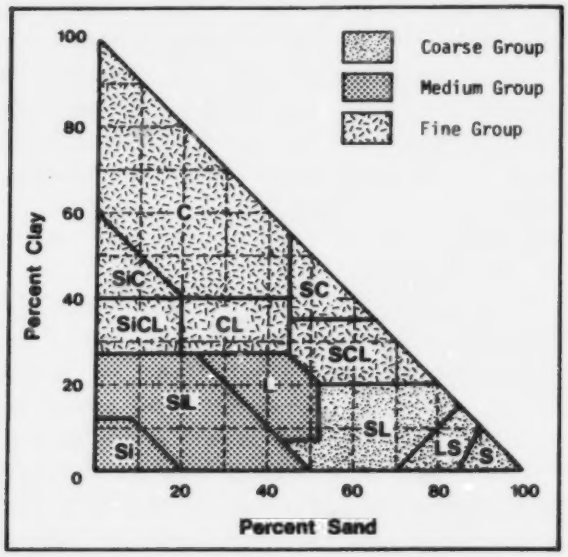


Figure 16: Soil textural classes

The results of grain-size analyses are usually presented in the form of a distribution curve (Casagrande curve). This curve is obtained by plotting particle diameter against percent of material finer by weight (Lambe, 1960). The steeper the curve, the more uniform are the grain sizes; a vertical line represents a perfectly uniform sample, one in which there is only one grain size.

The uniformity of the material is expressed by the uniformity coefficient which is the ratio of D_{60} to D_{10} where D_{60} is the soil particle diameter of which 60% of the soil particles are finer and

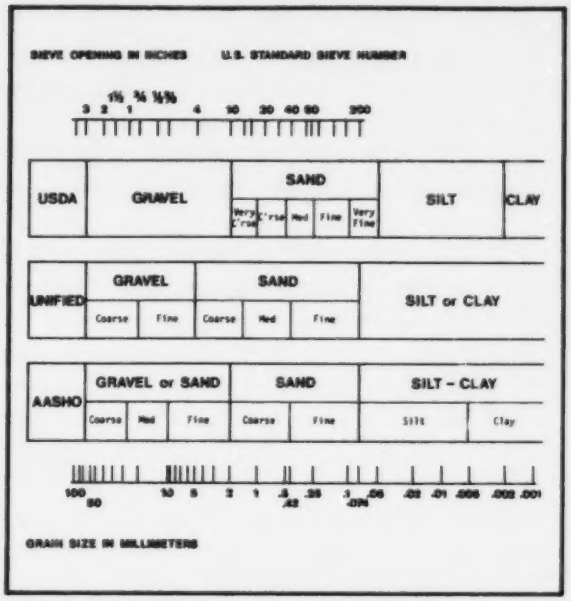


Figure 17: Comparison of soil particle sizes for the U.S.D.A., Unified and A.A.S.H.O. systems of classification

D_{10} is the corresponding value at 10% finer. A soil having a uniformity coefficient smaller than two would be considered uniform. Casagrande curves for four selected soil associations representing three different parent materials are given in Figure 18. None of them are considered to be uniform.

In Figure 18 fairly good gradation is represented by curve #4. Such material is more stable, can be more readily compacted, and has a higher shearing resistance and bearing capacity than material represented by curve #2.

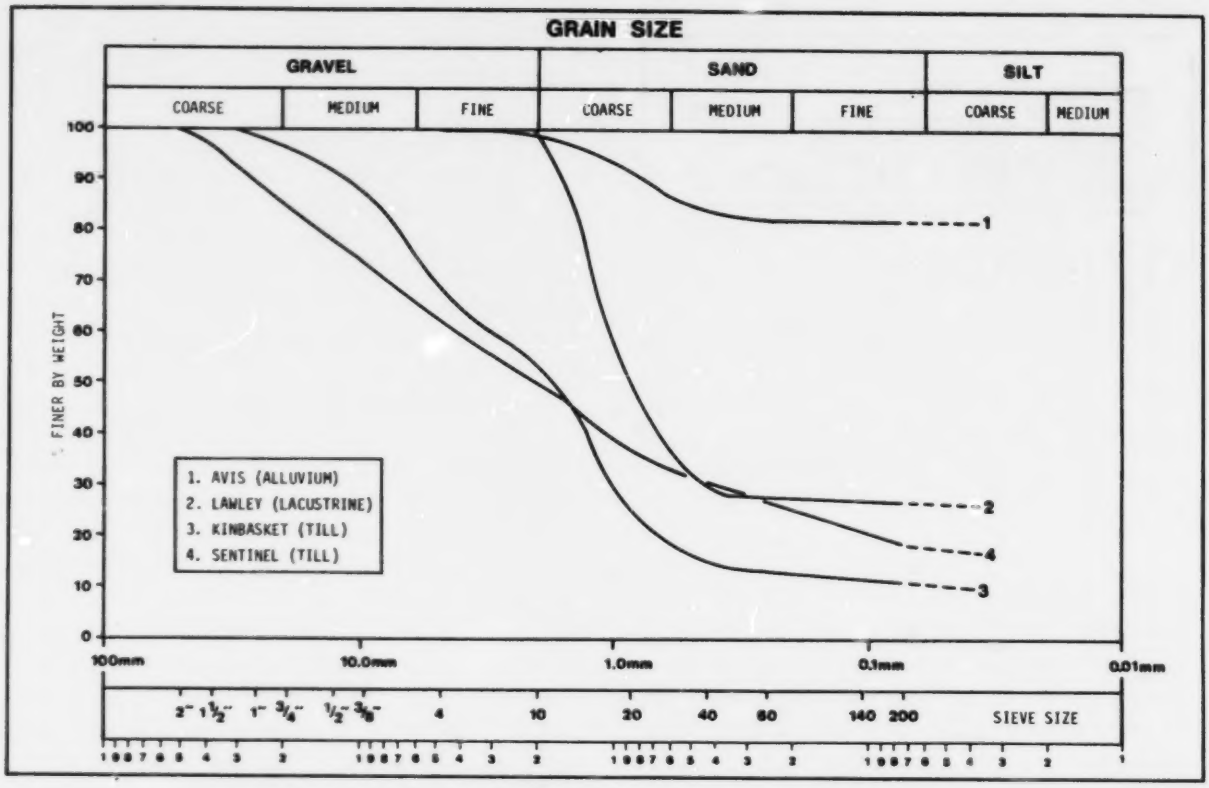


Figure 18: Grain size distribution of some parent materials in the Lardeau map area

4.12 GENERAL ENGINEERING INTERPRETATIONS PERTINENT TO ROAD CONSTRUCTION

The characteristics of the various coarse and fine-grained soil classes in the Unified System is given in Table 3 (Asphalt Institute, 1969). The soil associations occurring in the Lardeau map area are placed in one or more of the appropriate Unified groups according to their estimated properties.

A brief outline of the soil properties considered in the various columns of Table 3 follows.

4.121 Value of material as subgrade when not subject to frost action

The structural strength of a soil is determined by the combination of its cohesion, internal friction, compressibility, and elasticity properties. This column gives the suitability of each soil group for subgrade use provided it is not subject to frost action.

4.122 Value of material as a subbase when not subject to frost action

The limitations are fairly similar to those for subgrade. The penetration of frost below the non-heaving subbase material under the best drainage conditions produces on thawing, a softening of the subgrade soil beneath the subbase. Additional subbase material will overcome stability losses.

4.123 Potential frost action

This column indicates the relative susceptibility of the Unified soil group to frost heave. When water is present in the subgrade during periods of frost penetration, ice lenses form. The consequent ice expansion lifts the surface material which, in turn, is broken up by moving wheel loads (Figure 19).

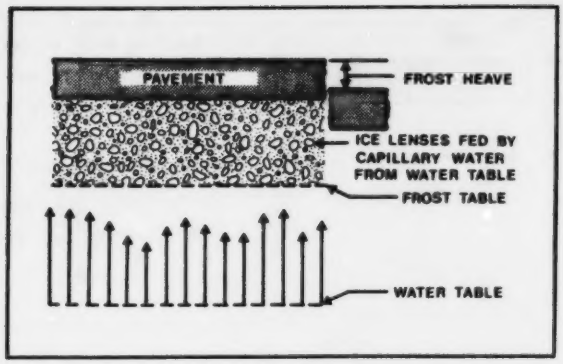


Figure 19: Frost heave is caused by ice lenses forming beneath the pavement or road surface

For ice layers or lenses to form in a soil, three basic conditions must be present: (1) freezing temperatures in the soil; (2) a water table close enough to the frost line to feed the growing ice lenses; and (3) soil characteristics favourable to the rapid movement of capillary water upward from the water table. Where freezing temperatures are prolonged and the frost line penetrates deep into the soil, the ice layers that form cause the soil to heave at the surface, in an amount equivalent to the thickness of all the ice layers. The three most common methods for reducing the probability of detrimental frost heave in a frost-susceptible soil are the use of non-frost-susceptible subbases and bases, lowered water tables, and impermeable cutoff blankets between the subgrade and the subbase or the base. High frost-action soils call for seasonal closure of road to heavy vehicles.

4.124 Compressibility and expansion

The compressibility of a soil is the decrease in volume of the mass when supporting a load. Compressibility is lowest in coarse-grained soils having grains that are in close contact; the volume of the mass decreases very slightly when these soils support heavy loads. Compressibility increases as the amount of fines present increases, and is highest in fine-grained soils containing organic matter.

4.125 Free drainage characteristics

Drainage characteristics are determined by properties of permeability, capillarity, and by grain size and porosity. An excellent rating implies free draining characteristics. These soils may also have rapid infiltration of water into the base or subgrade unless the water is diverted.

4.126 Compacting equipment

Soil compacting, related to compressibility and expansion, is a term which describes a process of densification in which the volume change results almost entirely from the expulsion of air from the soil mass. This is generally done by controlling the soil moisture.

The following is the compaction equipment recommended by the U.S. Corps of Engineers (U.S.D.A. 1971) to obtain the required density, when moisture content and layer thickness is controlled. Minimum equipment loadings specified are: Crawler tractor 30,000 pounds, rubber-tired wheel load 15,000 pounds, sheepsfoot roller 250 p.s.i.

Equipment	Most Suitable Unified Soil Group
Crawler tractor	GW, GP, SW, SP
Steel-wheeled roller	GW, GP
Rubber-tired roller	All groups excepting MH, CH, OH
Sheepsfoot roller	All groups excepting GW, GP, SW, SP

Note: Close control of moisture is required for GMd, SMd, and ML groups.

4.127 Shear strength when saturated

The shear strength of a soil indicates the relative resistance of that soil to sliding, when supporting a load. Cohesion, and therefore shearing strength, is not constant, but varies with

changes in water content, rate and time of loading, confining pressure, and numerous other factors.

Soils that are compacted at drier than optimum moisture content usually exhibit greater shear strength than those that are compacted at wetter than optimum. Soils composed of clean gravel (less than 5% fines) have the greatest resistance to sliding. Soil shear strength decreases as the fines increase, and is lowest in fine-grained organic soils (OL and OH).

4.128 Permeability characteristics

The permeability of compacted soil is the rate at which water moves through soil after compaction. Coarse-grained soils usually are much more permeable than fine-grained soils. The presence of small quantities of fines or cementing materials in coarse-grained soils or cracks, fissures, and holes in fine-grained soils sometimes alters this pattern. If a coarse-grained soil, after compaction, contains large continuous pores, the soil transmits water rapidly and is said to have high permeability. Because fine-grained soils contain very small, discontinuous pores, a compacted fine-grained soil transmits water very slowly and is said to have low permeability.

4.129 Workability as a construction material

The soil materials of groups GW and SW are excellent, while those in groups MH, CH, OH are poor construction materials.

The reader is referred to Table 13 in the Appendix for a list of rock types and their properties that may be relevant in engineering and construction.

4.13 ENGINEERING INTERPRETATIONS FOR VARIOUS SOILS OF THE LARDEAU MAP AREA

The estimated interpretations in Table 4 are based on engineering soil properties given in Tables 2 and 3.

When using the soil interpretive ratings, the following must be considered:

a) Interpretations do not eliminate the need for further detailed on-site evaluations by qualified persons.
b) Soil interpretations consider only those parameters implicit in the definition of each soil association. Other important limitations may exist that were not considered.
c) When applying soil interpretations for map units, users must realize that due to the variable nature of soils small inclusions of unmappable (due to scale) soils with different interpretations may be present.
d) Severe soil ratings do not necessarily imply that a site cannot be changed to remove, correct, or modify the soil limitation. The implication is that the more severe the rating, the more difficult it is to overcome the limitations inherent in the soil.
e) Interpretations were made only on the dominant soil in each soil association component. Significant soil association components such as seepage phases, lithic soil subgroups and changes from the modal soil will, in most cases, alter the interpretation.

Soils with slight limitations have properties favourable for the rated use. The degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.

Soils with moderate limitations have some properties that are significantly limiting for use, such as excessive slopes, rocky terrain or imperfect drainage. The degree of limitation may be overcome or modified by special planning, design, or maintenance. Soils with this rating may require treatment to modify limiting features, such as runoff control to reduce erosion.

Soils with severe limitations have one or more

Table 3: Generalized relationship between soil association, unified group and their estimated engineering properties

MAJOR DIVISIONS		LETTER	NAME	SOIL ASSOCIATION SYMBOL (a)	VALUE AS SUBGRADE WHEN NOT SUBJECT TO FROST ACTION (b)	VALUE AS SUBBASE WHEN NOT SUBJECT TO FROST ACTION (c)	POTENTIAL FROST ACTION (c)	COMPRESSIBILITY AND EXPANSION (d)	FREE DRAINAGE CHARACTERISTICS (e)	COMPACTION EQUIPMENT (f)	SHEAR STRENGTH (WHEN SAT.) (g)	PERMEABILITY CHARACTERISTICS (h)	WORKABILITY AS A CONSTRUCTION MATERIAL (i)
COARSE-GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines	KO,KE,KG,KE	Excellent	Excellent	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	Excellent	Pervious	Excellent
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	KO,KE,KG,KE,FT, FA	Good to excellent	Good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	Good	Very Pervious	Good
		GM d	Silty gravels, gravel-sand-silt mixtures	BS,BA,BC,BY,BZ, BT,BK,BO,BE,P, BH,CP,CY,CC,CF,	Good to excellent	Good	Slight to medium	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller, close control of moisture	Good	Semi-pervious to pervious	Good
		u		CL,CY,CE,CR,CH, CM,CB,CM	Good	Fair	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	Good	Semi-pervious to pervious	Good
		GC	Clayey gravels, gravel-sand-clay mixtures	FT,FA,SM,SR,SW	Good	Fair	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	Good to fair	Variable	Good
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines	GS	Good	Fair to good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	Excellent	Pervious	Excellent
		SP	Poorly graded sands or gravelly sands, little or no fines	GS	Fair to good	Fair	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	Good	Pervious	Fair
		SM d	Silty sands, sand-silt mixtures	NW,AS,BS,BA,BC, BY,BZ,BT,BK,BO, BE,BP,BH,CP,CX, CC,CF,CL,CY,CE, CR,CH,CM,CB,CM, MA,ML	Fair to good	Fair to good	Slight to high	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller, close control of moisture	Good	Semi-pervious	Fair
		u											
		SC	Clayey sands, sand-clay mixtures	SL,SB,SF,SA,SP, SD,ST	Poor to fair	Poor	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	Good	Semi-pervious	Fair
FINE-GRAINED SOILS	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	NW,AS,GS,SM,SR, SW	Poor to fair	Not suitable	Medium to very high	Slight to medium	Fair to poor	Rubber-tired roller, sheepsfoot roller	Good to fair	Semi-pervious to pervious	Good
		CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, lean clays	AS,SF,(MY,LY,LL)	Poor to fair	Not suitable	Medium to high	Medium	Practically impervious	Rubber-tired roller, sheepsfoot roller, close control of moisture	Fair	Semi-pervious to pervious	Fair
		OL	Organic silts and organic silty-clays of low plasticity		Poor	Not suitable	Medium to high	Medium to high	Poor	Rubber-tired roller, sheepsfoot roller	Fair	Impervious	Good to fair
	SILTS & CLAYS LIQUID LIMIT IS GREATER THAN 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic soils	MY,LY,LL	Poor	Not suitable	Medium to very high	High	Fair to poor	Rubber-tired roller, sheepsfoot roller	Poor	Semi-pervious	Fair
		CH	Inorganic clays of medium to high plasticity, organic silts	LY,(SF)	Poor to fair	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	Fair to poor	Semi-pervious	Poor
		OH	Organic clays of medium to high plasticity, organic silts	O	Poor to very poor	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	Poor	Impervious	Poor
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils	O	Not suitable	Not suitable	Slight	V. v high	Fair to poor	Sheepsfoot roller, rubber-tired roller Compaction not practical	Poor	Impervious Variable	Poor

properties unfavourable for the selected use, such as steep slopes, bedrock near the surface, flooding hazard or seasonal high water tables or a combination of these properties. The soils could be improved by reducing or removing the soil features that limit the use, but in most situations this would be very difficult and costly.

A rating of very severe is confined to soils requiring extreme alteration and which, for the most part, cannot be used for the selected purpose.

The degrees of suitability of the soils as a source of specified materials are expressed as good, fair, poor or very poor.

In Table 4, a number of subdivisions of the soil parent material were made on the basis of: depths to bedrock (zero-20 inches, 20 inches to five feet, greater than five feet) and type of soil parent material.

The criteria used to establish the degrees of limitation for the interpretations shown in the columns of Table 4 are given in Appendix E and are adapted from United States Department of Agriculture, Soil Conservation Service, Guide for Interpreting Engineering Uses of Soils, 1971.

4.131 Soil interpretations for septic tank absorption fields

Recorded observations of correctly designed and installed septic tank systems that have failed within a few years after installation often indicate severe soil limitation as a cause of failure. Clues to watch for are lush plant growth, seepage, or odour in the vicinity of the absorption system.

Although soils with rapid permeability have slight limitations, it should be noted that a contamination hazard may exist if ground water supplies, ponds, lakes, streams, or other water courses are nearby and receive seepage from the absorption field.

Field percolation tests are reliable only if the moisture is at or near field capacity when the test is run. In fact, nearly impermeable soils on which absorption fields have failed may give high percolation test results after periods of drought because large cracks may be present in the soil. In addition to soil properties that influence percolation rates, changes in the micro-organisms in the soil may also help or hinder the functioning of the absorption field after it is in operation. Because the methods of measuring percolation and permeability are different, the correlation between the two values is imperfect.

A seasonal water table should be at least four feet below the bottom of the trench at all times for soils rated as having slight limitations. Soils with a water table less than two feet below the bottom of the trench for extended periods have a severe limitation.

Impervious layers, including rock, should be four feet or more below the bottom of the tile trench floor. Creviced or fractured rock without an adequate soil cover permits unfiltered sewage to travel long distances through old or new aquifers, such as deeply cracked limestone. At least four feet of moderately coarse or finer textured soil material should be between the bottom of the tile trenches and such rock.

Very coarse textured soils (coarse loamy sand, coarse sand, and gravel) are relatively poor filtering materials. These soil materials permit unfiltered sewage to travel long distances. The ratings are based on permeability alone.

Soils that are subject to flooding have severe limitations even if the permeability is satisfactory and the ground water level is below four feet. Flood waters interfere with the functioning of the filter field and carry away unfiltered sewage. Without protection, areas subject to flooding are severely limited for on-site sewage disposal systems.

Table 4: Limitations of soil associations for selected engineering uses

SOIL PARENT MATERIAL	SOIL ASSOCIATION SYMBOL AND COMPONENT	DEGREE AND KIND OF LIMITATION FOR SEPTIC TANK ABSORPTION FIELDS	DEGREE AND KIND OF LIMITATION FOR SHALLOW EXCAVATIONS	DEGREE AND KIND OF SOIL LIMITATIONS FOR LOW BUILDINGS	DEGREE AND KIND OF SOIL LIMITATION FOR SANITARY TYPE LANDFILL	DEGREE AND KIND OF SOIL SUITABILITY AS SOIL COVER FOR AREA TYPE LANDFILLS	DEGREE AND KIND OF SOIL LIMITATION RATINGS FOR ROADS AND STREETS	DEGREE AND KIND OF SOIL LIMITATIONS FOR RESERVOIR AREAS AND SEWAGE LAGOONS	SOIL SUITABILITY AS A SOURCE OF CONCRETE AGGREGATES	SOIL SUITABILITY AS A SOURCE OF TOPSOIL	AVAILABLE WATER STORAGE CAPACITY	INFILTRATION GROUP	SURFACE EROSION POTENTIAL	SEDIMENTATION YIELD POTENTIAL
Recent fluvial deposits (Regosols)	$RS_1RS_2RB_1RB_2$	Slight-moderate, may have occasional high water table	Slight to moderate, sidewall instability	Slight to moderate, low bearing strength, moderate frost action	Moderate if depth to watertable >72" and soil is moderately well drained	Good to fair	Slight to moderate, moderate frost action	Moderate to severe, moderately high permeability, seepage hazard	Fair to poor	Fair	Low to moderate	A,B	Low	Low
Recent fluvial deposits (Gleysols)	$RS_2RS_4RB_2RB_4$	Moderate to severe, generally high water table, poor permeability	Moderate to severe	Moderate to severe, high water table, flooding, low bearing strength, frost action	Severe, due to high water table	Poor, poorly drained	Severe, poor drainage, high water table, frequent flooding	Severe, flooding and seepage hazard	Poor	Fair to good	Moderate	B,C	Low	Low to moderate
Very shallow (<20") colluvium derived from or overlying bedrock	$BS_3.BB_3.BC_4.BZ_4.$ $BT_5.BK_5BB_5.BB_5.$ $BK_5.BZ_5.BP_6.BP_5$ BY_6	Very severe, less than 20" soil material over bedrock, steep slopes	Very severe, shallow soils over rock, steep slope	Slight if built directly on rock with level slope, severe due to steep slope	Very severe, unsuitable for landfill	Poor, very shallow soil material overlying bedrock	Very severe, very shallow soil overlying bedrock	Very severe, steep slope, shallow soil material overlying bedrock	Unsuitable	Unsuitable	Very low	A	Moderate(due to limited amount of material)	Low
Shallow (<5') colluvium derived from or overlying bedrock	$BS_{1-2}.BB_{1-4}.BC_{1-}$ $BC_3.BB_{1-2}.BF.$ $BY_{1-4}.BZ_{1-5}.BT_{1-4}$ $BK_{1-4}.BK_4.BD_{1-3}.$ $BB_{1-4}.BC_{1-4}.BP_{1-5}$ $BP_{1-4}.BP_6.BM.$ $BB_{1-3}.$	Severe, less than 5' soil material over bedrock, often occur on steep slopes >30%	Severe-moderate, less than 5' material over bedrock, steep slopes	Slight on level slope, severe on steep slope	Severe, shallow soil depth overlying bedrock	Fair to poor, depending upon depth of materials and slope of material	Moderate, depending upon amount of blasting and depth of soil over rock	Severe, steep slope, pollution hazard, shallow soil material over rock	Unsuitable	Unsuitable as shallow material overlying bedrock	Low	A,(B)	Moderate to high	Low
Deep colluvium with coarse grained rock fragments	CP,CR,CC,CF	Severe, steep slopes	Severe, steep slopes, non-stable material	Moderate on level slope, severe on steep slope	Severe on steep slope, moderate on slope <25%, coarse grained soil	Fair, steep slope	Moderate, provided poor drainage on steep slopes is minimized	Severe, steep slope, frost permeability, pollution hazard	Poor	Poor	Low to moderate	A,(B)	Moderate	Low
Deep colluvium with mottled and fine grained rock fragments	CL,CY,CE,CR,CH, CN,CB,CD	Severe, steep slopes slow permeability	Severe, steep slopes, non-stable material	Moderate on level slope, severe on steep slope	Moderate on slope <25%, severe on steep slope	Fair, steep slope	Moderate, provided poor drainage on steep slopes is minimized	Moderate when slope is <7%, severe if slope is >7%	Poor	Poor to fair	Moderate	B,(C)	Moderate to to high	Moderate
Colluvium present on smoothed & avalanche tracts	CS,CT	Very severe, steep slopes, unsuitable	Very severe, non-stable material, steep slopes	Very severe, soil is unsuitable	Very severe, soil is unsuitable	Fair, steep slope	Severe, due to very steep slope and active avalanching	Very severe, soil is unsuitable	Fair to poor	Good to fair	Moderate	C	High	Low to moderate
Fluvial fans (without seepage)	$FA_{1-3}.FT_2$	Slight	Moderate to severe, stoniness	Slight to moderate, stoniness	Slight, fill may cause pollution	Fair to poor, excess stones	Slight to moderate, stoniness	Severe, high permeability, high pollution hazard	Fair	Fair	Low	A	Low	Low
Fluvial fans (with seepage)	$FA_4.FT_1.FT_3$	Slight to moderate, some seepage	Severe, some seepage may occur, sidewall instability	Moderate due to stoniness and seepage	Moderate, increased subsoil seepage	Fair to poor, excess stones	Slight to moderate, stoniness and seepage, danger of frequent floods	Severe, high permeability, high pollution hazard	Fair to poor	Fair	Low to moderate	A(B)	Low	Low
Sandy, glacio-fluvial deposits	GS	Slight, may cause seepage on exposure of impermeable layer	Slight to moderate, sidewall instability	Slight	Severe, permeability is too rapid	Good	Slight to moderate, poor load supporting capacity in fine sands	Severe, high permeability and pollution hazard, seepage of liquid	Good	Poor	Low	A	Low	Low
Gravelly and sandy glaciofluvial deposits	KB,KE,KG,KZ	Slight to moderate on steeper slopes	Slight to moderate, sidewall instability	Slight to moderate, depending upon slope and stoniness	Severe, rapid permeability	Fair to poor, excessive stones and boulders	Slight, good supply of sand and gravel	Severe, high permeability and pollution hazard, seepage of liquid	Good	Poor (VE-Fair)	Low	A	Low (except near bluffs)	Low
Lacustrine deposits	LY,LL,MY	Severe, slow permeability	Moderate (may have frost), sidewall instability	Moderate to severe depending upon slope, high shrink-swell potential	Moderate to severe, very slow permeability	Good to fair, fines to soil	Severe, high frost action, high shrink-swell potential, high erodibility, slippery when wet	Slight to moderate where seepage does not occur, slow permeability	Poor to fair, depending on local conditions	Good to fair	High	C,D	Moderate on level slopes, severe on steeper slopes	High
Shallow colluvium overlying or derived from bedrock	BR,BL	Severe, shallow soil over rock, deep frost penetration	Severe, shallow material over bedrock deep freezing conditions	Moderate to severe, high frost action and seepage of moisture	Severe, shallow soil overlying bedrock	Fair to poor depending upon depth of materials and slope of material	Moderate, shallow soil material over rock, moderately high frost action	Severe, shallow soil material overlying rock, high frost action	Unsuitable	Poor to unsuitable	Low to moderate	C,D	Moderate	High to moderate
Glacial till with coarse grained stone fragments	SR,SE,SH	Moderate to severe, steep slopes	Moderate to severe, difficult to work, sidewall instability, slope	Slight to moderate on level slope, severe on steep slopes	Slight to moderate, depending on slope	Good to fair, depending upon consistence	Moderate, steep slopes, frost action, erodibility	Moderate when slope is <7%, moderately high permeability	Poor	Poor	Low to moderate	B-C	Moderate to severe	Moderate
Glacial till with mottled and fine grained fragments	SL,SB,SF,SK,SP, SD,ST	Severe, slow permeability, steep slopes	Moderate, sidewall instability, steep slope	Slight to moderate on level slope, severe on steep slopes	Slight to moderate, depending upon slope	Good to fair depending on consistence	Moderate to severe, steep slopes, frost action, high erodibility	Slight to moderate when slope is <7% slow permeability	Poor	Poor	Moderate	C(D)	Severe	High
Drumlinized glacial till	KB,KY	Moderate, slow permeability	Slight to moderate, expected till difficult to work	Slight on slopes less than 8%	Slight	Good to fair, depending upon consistence	Slight to moderate, slight frost action	Slight when slope is <17%	Poor	Poor to fair	Moderate	B,C	Moderate	Moderate to low
Talus cones	TR,TK	Very severe, steep slopes, unsuitable	Very severe, non-stable material, steep slopes	Very severe, soil is unsuitable for buildings	Very severe, unsuitable for landfill	Poor, unsuitable	Very severe, talus is unsuitable for road construction	Very severe, material unsuitable	Unsuitable	Unsuitable	Low to nil	A	severe	Low

Soils with slopes of less than 8% are the best sites for septic tank sewage disposal systems considering construction and the successful operation of an absorption field. Mechanical problems of layout and construction increase with the steepness of slope. Lateral seepage or down-slope flow is a problem on sloping soils, especially where bands of impermeable material occur within a depth of four feet. Large rocks, boulders, and rock outcrops increase construction costs as the tile grade is difficult to maintain if the obstacle cannot be removed. Trench lines can be installed and the grade maintained around these obstacles on nearly level soils.

Detergents in solution are readily transmitted through some soils and may contaminate ground water supplies. Sodium salts from water softeners and other sources tend to disperse the clay in the soil and to reduce the effectiveness of the absorption field.

4.132 Soil interpretations for shallow excavations

Shallow excavations are those that require excavating or trenching to a depth of five or six feet. It should be remembered that limitation ratings for shallow excavations alone, though highly relevant, are insufficient for interpreting soil suitability for such uses as dwellings with basements, sanitary landfills, cemeteries, and underground utility lines such as sewers, pipelines, and cables. Additional soil features must be considered in evaluating soils for these uses. For example, additional information about shrink-swell potential and corrosivity is needed to determine the suitability of soils for pipelines. Backfilling is required for most uses, but not for open ditches.

In soils used for shallow excavations, desirable characteristics are: good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops and large stones, and no flooding hazard.

4.133 Soil interpretations for low dwellings

The properties that affect foundations are emphasized in the soil ratings for low dwellings. Other factors to be considered are slope, susceptibility to flooding, seasonal wetness, and other hydrologic conditions. The properties influencing foundation support are those affecting bearing capacity and settlement under load, and those affect cost of excavation and construction. Properties affecting bearing strength and settlement of the natural soil are density, wetness and seepage, flooding, plasticity, texture, and shrink-swell potential. Properties influencing the amount and cost of excavation are wetness, slope, depth to bedrock, stoniness and rockiness. Also considered are soil properties, particularly depth to bedrock, that influence installation of utility lines. It is important to note that on-site investigations are needed for interpretations relevant to detailed design of foundations and to specific placement of buildings and utility lines.

4.134 Soil interpretation for trench-type sanitary landfill

The trench-type sanitary landfill is an excavated trench in which refuse is buried daily, or more frequently if necessary. The refuse is covered with a backfill material at least six inches thick. When the trench is full, a final cover of soil material at least two feet thick is placed over the landfill.

Because trenches as deep as 15 feet or more are used for many landfills, geologic investigation is needed to determine the potential for pollution of ground water and to ascertain the design needed. These investigations, include examination of stratification, rock formations, hydrology, and the like, which might conduct leachates to aquifers, wells, water courses, and other water sources. The presence of hard, non-rippable bedrock, creviced bedrock, or sandy or gravelly

strata in or immediately underlying the proposed trench bottom is undesirable as these factors make it difficult to excavate and could result in pollution of underground water.

4.135 Soil interpretations for area-type landfill

Various soil materials can be used for the backfilling of excavations, washouts, and a variety of other purposes. However, due to their properties, some materials are better suited for this purpose than others. These include loam and clay loam tills as well as some finer textured lacustrine materials.

4.136 Soil interpretations for roads and streets

Soil properties that affect road construction are load supporting capacity, subgrade stability, internal soil drainage and wetness, flooding, slope, depth to bedrock, content of large stones and susceptibility to frost action. A subgrade composed of coarse gravelly materials with the addition of finer-textured materials having low shrink-swell potential is most suitable.

4.137 Soil interpretations for water reservoir areas or sewage lagoons

A sewage lagoon (aerobic) is a shallow lake used to hold sewage for the time required for bacterial decomposition. Soil suitability for sewage lagoons must be considered for two functions: (1) as a vessel for the impounded area; and (2) as soil material for the enclosed embankment. The requirements for the embankment are the same as for other embankments designed to impound water. There must be enough soil material suitable for the structure, and, when the lagoon is properly constructed, it must be capable of holding water with minimum seepage. The material should be free of coarse fragments (over 10 inches in diameter) that interfere with compaction.

Soil requirements for basin floors of lagoons have: (1) a slow rate of seepage; (2) even surface of low gradient and low relief; and (3) little or no organic matter. Specifications for lagoons usually state that the depth of the liquid should be not less than two feet and generally not more than five feet; the floor should be level or nearly so; and the materials for the basin floor should be so nearly impervious as to preclude excessive loss of liquid. The relatively impervious soil material should be at least four feet thick. This is especially important when the local water supply comes from shallow wells that may become contaminated.

The slight limitation class includes soils that are effective in functioning as sealed-basin floors and that are low in organic matter. Soils in the moderate limitation class are those that require special practices or treatment to modify limitations to their use as sites for sewage lagoons. Soils placed in the severe limitation class are those that are very porous, or high in organic matter, or have other limitations that prevent their use as sites for sewage lagoons.

4.138 Soil suitability as a source of coarse aggregates

Soil factors to consider here are depth to water table, presence of stones and boulders, presence and amount of finer particles and thickness of sand and gravel deposits. These ratings are primarily intended to guide readers to sources of these materials. The ratings are good, fair, poor and unsuitable.

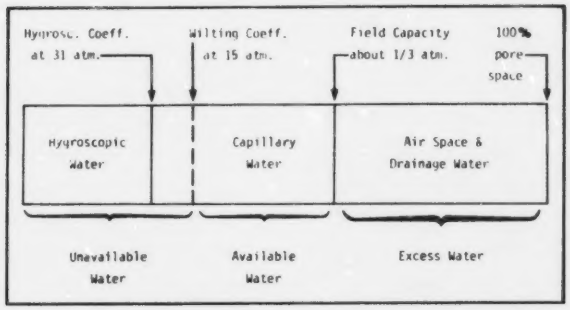
4.139 Soil suitability as a source of topsoil

Soil suitability for topsoil is determined by the natural fertility and ease of working and spreading the soil material for preparing a seedbed. The texture of the soil material, ease of excavation and the content of coarse fragments (stones) are characteristics that affect its suitability for topsoil. Factors of slope and depth to water table were not considered. The ratings are good, fair, poor and unsuitable.

4.2 SOIL INTERPRETATIONS PERTAINING TO HYDROLOGY, MASS MOVEMENT AND ERODIBILITY OF MATERIALS

The soil associations in the Lardeau map area are grouped according to depth to bedrock and mode of deposition. These groups and interpretations are noted in Table 4 and can be useful for broad regional management considerations.

4.21 AVAILABLE WATER (MOISTURE) STORAGE CAPACITY



The above diagram shows the relation between the various forms of soil moisture.

The available water generally considered as useable by plants is that held between field capacity and the wilting coefficient, and the amount is primarily dependent upon soil texture. In the following groups it is assumed that the texture is uniform throughout the top four feet of the profile. The following ratings refer to the amount of water storage expected in the upper four foot soil section (Brownlee, 1976).

Low - These soils store less than one and one half inches of water per foot of soil and are coarse to very coarse textured (gravels, sands, sandy loam, loamy sand and sandy loam). Water storage capacity is low.

Moderate - These are soils that store one and one half to two inches of water per foot of soil. The soils are generally medium textured and include silts, silt loam, loam, sandy clay loam, and clay loam. Water storage capacity is moderate.

High - Water storage in these soils is in excess of two inches of water per foot of soil. The soils are fine textured (clay, silty clay, silty clay loam, sandy clay and some silt loams). Water storage capacity is high.

4.22 INFILTRATION ABILITY

This interpretation groups the soils into four classes, indicating the general infiltration and water movement capability of the soils. This method of rating has been developed by the U.S. Soil Conservation Service. (Snyder and Wade, 1970). The infiltration rate depends upon the type of surface soil texture, rock fragment content, structure, porosity, bulk density and organic matter content.

Group A - These soils have high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well-to-excessively drained sand or gravel or both. They have a high rate of water transmission and result in a low runoff potential. Water enters soil surface very rapidly and rarely ponds. Soils are coarse-textured, porous, loose and usually single-grained.

Group B - The soils in Group B have moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, moderately well to well drained soils with medium to coarse textures. These soils have a moderate rate of water transmission. Water may pond for short periods (a few days) following very intensive rainfall. Soils are medium

textured and well aggregated.

Group C - Group C soils have slow infiltration rates when thoroughly wetted and consist chiefly of: (1) soils with a layer that impedes the downward movement of water; or, (2) soils with moderately fine to fine textures. These soils have a slow rate of water transmission.

Group D - The soils of Group D have very slow infiltration rates when thoroughly wetted and consist chiefly of: (1) clay soils with high swelling potential; (2) soils with a high permanent water table; (3) soils with claypan or clay layer at or near the surface; and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission. Soils are poorly aggregated and water stands on surface soil for long periods.

Note: Surface logging slash and the forest floor vegetation increases or maintains infiltration capacity by breaking raindrop impact and preventing clogging of soil pores. Such organic materials also act as a medium through which some lateral flow may occur, limiting rapid overland runoff and trapping some sediments. When severe burning takes place the hydrologic effectiveness of surface slash and the forest floor is greatly reduced. This is most serious on shallow soils and other soils which have an impermeable layer near the mineral surface.

4.23 SUBSOIL EROSION POTENTIAL

This interpretation indicates the potential for subsoil erosion by water. It includes erosion which takes place after the surface soil and all the vegetative cover, including litter, has been removed. Factors considered in making ratings are texture and structure of subsoil materials, slope, permeability, compaction, climate, and landform. The ratings increase drastically on steep slopes. These groups are:

Low - Factors are such that little or no erosion occurs. ...y little evidence of erosion.

Moderate - Considerable erosion occurs such as rills and small gullies. Factors indicate considerable erosion is likely to occur.

High - Factors indicate severe erosion may occur.

4.24 SEDIMENTATION YIELD POTENTIAL

This interpretation indicates the potential for sedimentation or pollution from silt and clay particles carried in suspension following timber harvest, road construction, or other activities. The factors considered in making these ratings are soil texture and structure, drainage patterns and landform. Another very important factor to consider is climate. The intensity and frequency of rainfall is particularly important in making ratings for this soil interpretation. However, due to limited site specific climate (rainfall intensity) data, this factor was not considered.

Most sediment contributions to streams result from failures of poorly planned road segments. Small landslides occur as a consequence of oversteepened cut-and-fill slopes, interrupted subsurface drainage, removal of physical root support, and the failure of culverts because of blockage or improper location.

The three ratings are:

Low - The sedimentation levels of silt and clay particles are not expected to be significant following soil disturbance. Soils are generally moderately coarse textured.

Moderate - The sedimentation levels of silt and

clay particles may be significantly increased following soil disturbance, with moderate loss of water quality and damage to fisheries. The soils are generally medium textured.

High - The sedimentation levels of silt and clay particles are expected to be high following soil disturbance. The streams become turbid and there is considerable loss of water quality and damage to fisheries. The soils are generally fine to moderately fine textured.

4.25 INTERPRETATIONS FOR MASS MOVEMENT POTENTIAL

The mass movement potential of soil as used here is an estimate of the stability of landscapes. All categories of mass movement from surface creep to landslides, are included (Swanston and Dyrness, 1973).

Soil mass movement involves the downslope movement of soil, primarily from the force of gravity. The movement ranges widely in surface form, speed of movement, and volume of material moved downslope. It ranges from spectacular debris avalanches and flows to the slow, downward creep of an entire hillside.

The three main types of mass movement are:

a) Debris avalanches and debris flows produced by instantaneous failure in shallow soils overlying an impermeable surface. These soils are usually coarse textured and low in clay content.
b) Creep, slumps, and earthflows, resulting from quasi-viscous flow and progressive failure of deeply weathered materials. Speed of movement ranges from a barely perceptible creep to high velocity slumps and earthflows.
c) Dry ravel, dry creep, and sliding, involving downslope movement of single particles and thin sheets of coarse, cohesionless material on steep, sparsely vegetated slopes.

The mode of failure and subsequent downslope movement of the soil mass depends greatly on soil depth, degree of cohesion, and soil water content. Usually, debris avalanches and debris flows result from loss of stability of a relatively shallow, cohesionless soil mass on steep slopes as a consequence of surface loading, such as side casting and road fills, increased soil water levels, removal of mechanical support, or a combination of all these. Creep, slump and earth flows most commonly occur on slopes characterized by deep, cohesive soil parent materials and may be initiated or accelerated by the same modifying conditions. Dry ravel requires bare, granular soil and either lack of surface moisture or presence of moisture and active freeze-thaw cycles.

Binding by root systems, cohesive strength of the soil, low slope angles, and unsaturated soil conditions tend to enhance soil shear strength, minimizing slope failures. After timber harvesting on steep slopes, the decay of root systems and changes in the water regime leading to local saturation may increase slope failures.

Predictions of mass movement potential require the knowledge and understanding of the relationships of geology, topography, climate and vegetation. The interactions of these components of the landscape can be interpreted as an indication of type of stability.

The following factors affect mass movement:

a) Status of moisture within the soil. Dry materials act differently than wet, saturated materials. The former are generally more stable, while the latter tend to be much less so.
b) Type of geologic material, includes both the soil mantle and the underlying bedrock. The nature of the material reflects the mineralogy, rock content,

shape of the rock fragments, orientation of bedding planes, joints and other structures, the soil-bedrock interface, weathering characteristics and particle size-distribution variation. The texture of the soil parent material together with its degree of cohesion, shear strength, and structure imparts a wide variability to the stability of the material.

c) Topography is the combination of surface features expressing the "lay of the land". The characteristics of slope and aspect are the main topographic considerations in mass movement potential. The slope angle and the shape and length of slope, are critical considerations. Generally the steeper the slope, the greater is the hazard.

d) Climatic conditions affecting mass movement potential include the range of seasonal weather factors. Precipitation distribution together with snow-melt and high intensity storms are the dominant factors. Additional precipitation loads the surface material and results in buoyancy effects, shear strength reduction, and increases the seepage force of ground water.

The climatic effect is more prevalent on north slopes because of the microclimate created by the topography and slower evaporation rates.

e) The vegetative cover offers some resistance to mass movement through the binding and holding effect of roots and utilization of soil water. The degree of natural vegetative disturbance is often a clue to the natural stability of a site. Recently-logged or otherwise disturbed areas may create newly active areas prone to soil creep and surface slumping because root decay may then diminish the binding effect to the slope. Revegetation, either natural or artificial will counteract this over time and will again increase stability and resistance to mass movement.

f) Gravity is the driving force involved in mass movement. The nature of the geologic material, combined with the slope angle relates to shear strength. In saturated soils, the excess water causes three important consequences: (1) increased shear stress along potential sliding surfaces; (2) decreased shear resistance resulting from high pore-water pressure; and (3) slope loading. When slope loading exceeds shear resistance, movement occurs.

Evidence of past mass movement may be inferred as follows:

a) Hummocky topography present below escarpment scars may show former slippage and may serve as an indicator of unstable conditions.

b) Pothole lakes may indicate the presence of soluble limestone with underground drainage and resulting underground slumping.

c) Bent trunks and leaning trees indicate unstable soil surface and a slow movement of the whole material sheet downslope.

d) Disorderly sequence of soil materials and horizons in a soil profile provides evidence of former movement or churning of the surface.

e) The presence of crescent-shaped scars on the hillside above the soil slump often indicates former mass movement activity.

The estimation of mass movement potential as explained here is a subjective evaluation. There are no positive methods of determining stability. Man is neither capable, nor are funds available, to study in detail, all slopes and expected impacts of the different kinds of construction or other disturbances. As a rule of thumb, these are typical situations to avoid in construction:

a) Restriction of ground-water flow and seepage by sidehill fill. Culverts should be used.

b) Overloading of weak, underlying soil or rock on slope by fill or side casts.
c) Oversteepening of cuts in unstable soil or rock.
d) Removal of a thick mantle of pervious soil which has been a natural restraining blanket.
e) Diversion of natural surface drainage pattern.
f) Exposure of material which softens when exposed to air and surface water.

The degree of investigation, as a general rule, depends on the risks involved and the susceptibility of the surrounding country to movement. Areas with ratings of moderate and high potential should be evaluated by specialists in soil mechanics and engineering geology. This may require deep drilling, seismographic studies and laboratory tests.

In Table 5, each dominant soil association component within the project area has been placed into one of four mass movement hazard groups depending on their characteristics (excluding topography). The factors primarily considered are vegetative cover, climatic environment, type of geologic and parent material and moisture status. Group I are the most stable soils and Group IV are the least stable. It should be noted, that only the dominant soil association is rated in this table. Mapping complexes should be handled by selecting the soil association in the complex which falls into the more severe stability group when the soil occupies 30% or more of the mapping unit.

When the mass movement hazard groups are plotted against slope classes of increasing steepness, the resulting graph indicates when each group has a slight, moderate or severe hazard for mass movement.

Group I - This group includes generally stable soils that have very coarse to coarse textures. Soil parent materials are of fluvial and glaciofluvial origin. Typical ice contact, fluvial fan and glaciofluvial terraced materials are included in this category. The depth of soil parent material is greater than 10 feet and is generally well to rapidly drained. The associated vegetation is composed primarily of deep rooted plant species.

Group II - Moderately stable soils which are generally medium to coarse textured with high bearing strength or coarse textured colluvial soils make up Group II. The soils overlying bedrock are more than five feet deep. The soils are usually well drained and vegetated with a combination of shallow and deep rooted plant species. Some moderately coarse textured glacial till soils are included in this group.

Group III- Group III is made up of unstable soils, such as clay loam textured soils in a dry environment and silt loam to clay loam textured soils in a moister environment. Soil parent material depth is variable. Glacial till soils are medium textured. The soils are generally well to moderately well drained. The bedrock from which some shallow soils (less than five feet of soil overlying bedrock) developed, has cleavage and fracture planes parallel to the surface slope and is generally of shaly and argillitic origin.

Group IV - Group IV includes some soils with silty and very fine sandy soil textures in moist and cool environments. In these areas the soils are often composed of colluvial veneers (less than five feet soil overlying bedrock) and are acted upon by nivation and solifluction. Steep cutbanks of fine-

textured soils are unstable in any climatic environment and in seepage sites of fine-textured glacial till materials the instability increases. Talus and avalanche tracks have a severe mass movement hazard due to slope.

It should be pointed out, that Tables 5 and 6 can be potentially misleading. The ratings apply only to the dominant soil of the soil association. Significant included soils may vary due to drainage or depth to bedrock and have very different ratings. The reader is referred to Appendix G for a listing of topographic classes and their corresponding conversion to % slope.

Areas rated slight include known, stable geologic formations. The slopes are generally less than 30% with south and southwest aspects and have soils that are generally coarse textured.

Areas rated moderate consist of geologic material of questionable stability, such as deeply weathered bedrock dipping with the slope, medium and finer textured or poorly graded soils or interbedded sedimentary rock formations.

Areas rated severe include historically unstable geologic formations and they may exhibit evidence of past mass movement.

Low lying recent fluvial soils with high water tables and in danger of flooding, as illustrated on Plate 20, are unsuitable for building. Septic effluent may cause pollution of nearby streams and lakes. Plate 21 shows an example of severe slumping which has occurred on lacustrine silts and clays near an escarpment. Slumping and mass movement occurs in some finer textured glacial till soils (Group III mass movement hazard) if ground cover is removed (see Plate 22).

Plate 20

Plate 21

Table 5: Soil associations grouped according to mass movement hazard

GROUP	SOIL ASSOCIATION SYMBOL	TOPOGRAPHIC CLASSES										
		E	E	EF	FE	F	FG	GF	G	GH	HG	H
I	FA, FT, KE, KG, KO, KX											
II	AS, BA, BB, BC, BF, BH, BK, BO, BP, BR, BS, BT, BY, CB, CC, CE, CL, CN, CP, CR, CW, CX, CY, GS, KB, NW, SL, SN, SR, ST, WY	SLIGHT										
III	BE, BM, BU, BX, CF, CH, SA, SB, SD, SF, SH, SP					MODERATE						
IV	CS, CT, Li, LY, MY, RA, RL, YK, YR								SEVERE			

Plate 22

4.26 INTERPRETATIONS FOR SOIL EROSION HAZARD RATING

The soil associations are grouped into three qualitative classes of soil erosion hazard based on reconnaissance soil information, including slope gradient, soil parent material, soil texture, soil structure and estimate of bulk density, percolation and infiltration characteristics. A general rating is given for each soil association.

The types of erosion include sheet, rill and gully erosion. The ratings assume that man's disturbance of the landscape will follow good management practices; such that all roads and skid trails be properly waterbarred and that slash burning may be a permissable management tool on slight to moderate erosion hazard sites. The ratings also assume a reasonable amount of debris and that lesser vegetation will remain on the surface after soil disturbance (almost all bare

soil surfaces on slopes greater than 15% have severe erosion hazard).

Where conventional timber harvesting is carried out, most of the erosion which occurs is associated with the access roads and trails, rather than the logged areas themselves.

Soil erodibility groups

The intent of these groupings is to enable the user to produce a more detailed representation of soil erodibility in map form.

Each soil dominant association component has been placed in one of four erodibility groups (Table 6) depending on their water stable aggregates, bulk densities, soil textures, parent materials, soil structure, infiltration, percolation, and climate, regardless of topography. The soils in Group I are the least erodible and Group IV, are extremely erodible. The topography together with the erodibility group, provides the erosion hazard rating. Map complexes can be handled by selecting the soil association in the complex which falls into the more severe erodibility group when the soil association occupies 30% or more of the map unit.

Group I - consists of soils developed from very coarse textured soil parent materials such as gravelly glaciofluvial deposits, fluvial fans, talus, and coarse-textured colluvium.

Group II - consists of soils developed from recent fluvial deposits, deep medium and moderately fine textured colluvium, coarse textured glacial till and fine sandy glaciofluvial materials.

Group III- is composed of all soils developed from medium and finer textured glacial till as well as moister, somewhat fine textured shallow colluvium overlying bedrock.

Group IV - consists of soils developed from lacustrine soil parent materials.

Three categories of potential soil erosion hazard are employed. These are:

Slight - No to slight erosion hazard. No special consideration is necessary to minimize soil erosion hazard. Broadcast burning can be a forest management tool when necessary. On fine-textured soils, soil disturbance should be avoided during wet periods. Slopes are generally less than 30%.

Moderate - These soils have moderate sheet, rill and/or gully erosion hazard. Slopes are generally from 20 to 50%, but include areas of silts and fine sands from 8 to 20% slope. Special consideration should be given to placement and maintenance of culverts. There should be minimal soil disturbance on shallow soils overlying bedrock and along permanent and intermittent stream channels. Road construction and other disturbances should be avoided when the soils are wet.

Severe - These soils are subject to severe sheet, rill and/or gully erosion. Slopes are generally greater than 50%. Careful management practices should be emphasized in road location, placement and maintenance of culverts and in cut-and-fill operations.

Table 6: Soil associations grouped according to soil erosion hazard

GROUP	SOIL ASSOCIATION SYMBOL	TOPOGRAPHIC CLASSES A-C D ED-DE E EF FE F FG GF G GH HG H
I	BB, BF, BH, BP, BR, BT, CB, CC, CP, CR, CX, FA, FT, KB, KE, KG, KO, KX, WY, YK, YR	SLIGHT
II	AS, BA, BC, BE, BK, BM, BO, BS, BU, BY, BX, CE, CF, CH, CL, CN, CW, CY, GS, NW, SH, SN, SR	MODERATE
III	CS, CT, RA, RL, SA, SB, SD, SF, SL, SP, ST	SEVERE
IV	LI, LY, MY	

Note: All glaciers have a high erosion hazard. Most bedrock areas have slight erosion hazard, except in soft weatherable bedrock areas. Topography on bedrock areas is often very steep.

4.3 SOIL INTERPRETATIONS FOR FORESTRY

Forestry is a very important land use in the Lardeau map area. It contains parts of the Windermere, Upper Kootenay, Lardeau, Slocan, Nakusp and Arrowhead Public Sustained Yield Units as well as portions of Tree Farm Licences 23 and 14.

A number of soil interpretations for forestry is presented in Table 7 and are based on guidelines and other pertinent information in Kowall, 1974.

4.31 POTENTIAL CAPABILITY (CAPABILITY CLASSES)

The potential capability relates to the soils capacity to grow trees under naturally occurring, fully stocked conditions. It was determined by locating and measuring forest productivity plots on a variety of soils. The methodology of locating and measuring the plots, and assessing the forest capability is outlined by Kowall, 1971. The seven capability classes are based on a productivity range as follows:

Class 7 has a mean annual increment range of 0-10 cu. ft./acre/year; Class 6, 11-30; Class 5, 31-50; Class 4, 51-70; Class 3, 71-90; ; Class 2, 91-110; Class 1, 111-130. Class 1a, 131-150; Class 1b, 151-170; Class 1c, 171-190, etc.

Subclasses are attached to capability classes 2 to 7 indicating the nature of the soil (or climatic) limitations present. Class 1 (and its subdivisions) is assumed to have no limitations to tree growth and therefore has no subclass designation. The subclasses used to indicate limitations for tree growth are: A - droughty or arid conditions as a result of climate; C - combination of more than one limiting climatic factor(s); D - physical restriction to rooting by dense or consolidated layers other than bedrock; H - low

temperatures (soil and air); M - soil moisture deficiency; R - restriction of rooting zone by bedrock; S - a combination of soil factors that collectively lower the capability class; and W - soil moisture excess (McCormack, 1968).

Land capability for forestry maps at a scale of 1:125,000 have been produced and are available from the Resource Analysis Branch, Ministry of the Environment, Parliament Buildings, Victoria, B.C. The information from these maps has been generalized and is shown in Figure 20.

4.32 TREE SPECIES ASSOCIATED WITH POTENTIAL CAPABILITY CLASS

Column 2 of Table 7 lists the tree species which produce, or can be expected to produce, the potential productivity indicated in the foregoing section. The species are usually those that are most suited to the soil, climate and topographic factors present and can be expected to grow well if planted. The tree species (symbol) include alpine fir (alF), black cottonwood (bCo), lodgepole pine (lP), western hemlock (wH), white spruce (wS), Douglas-fir (D), western white pine (wP), Engelmann spruce (eS), western larch (wL), and western red cedar (wC).

4.33 NATURAL REGENERATION POTENTIAL

Soil characteristics, climate, aspect, elevation, frost potential, brush competition, and suitable tree species determine generally the potential of a site to regenerate tree cover naturally. Other factors that influence regeneration are the condition of the seedbed, distance from an adequate seed source, prevailing wind directions, and shade requirements of the various kinds of seedlings.

When assessing the natural regeneration potential, it is assumed that an adequate seed supply is present. There is an inverse relationship between brush competition and natural regeneration potential - if the former is high, the latter is usually too low. This relationship is particularly applicable to Douglas-fir, lodgepole pine, western larch and other pioneering species. It delays regeneration by shade tolerant species such as western red cedar, western hemlock, Engelmann spruce and alpine fir. The three natural regeneration ratings are:

Low - This rating indicates that major natural regeneration problems can be expected. Several years may elapse before an adequate stocking level is achieved. Artificial regeneration and/or site preparation is required.

Medium - This rating indicates that some natural regeneration problems will be encountered in obtaining a satisfactory stocking level. Usually regeneration is spotty and some artificial regeneration or site preparation may be necessary.

High - This rating indicates that generally no natural regeneration problems will be encountered in obtaining a satisfactory stocking level of desirable tree species.

4.34 LIMITS TO NATURAL REGENERATION POTENTIAL

The major limitations to natural regeneration of desirable tree species are brush competition and the following factors:

1. Frost heaving which usually occurs on clayey and silty soils;
2. Low fertility levels due to coarse soil textures (i.e. gravels and sands);
3. Fertility imbalances due to high lime content in and below the solum;
4. Low water holding capacities and rapid percolation rates in coarse textured soils;
5. Drought conditions due to high evapotranspiration and low precipitation levels;
6. Soil wetness which limits aeration;

Figure 20: Generalized land capability for forestry of the Lardeau map area

7. Cold soil and air temperatures, short growing season, and wind exposure, usually associated with high elevations;
8. Climatic limitations such as aridity, wind exposure and adverse aspect and high surface soil temperatures in summer, usually associated with the lower elevations;
9. Unstable soil surfaces due to avalanching and snow chutes;
10. Unstable soils subject to mass movement;
11. Shallow soils overlying bedrock which provide only a shallow rooting medium;
12. High contents of coarse fragments (stones, boulders) which reduce the soil rooting medium.

4.35 NATURAL REGENERATION TREE SPECIES

Natural regeneration tree species are those indigenous species that are likely to regenerate naturally assuming a seed source is nearby. In addition to the species associated with the potential capabilities in column 2 on Table 7, the following species are also included: whitebark pine (whP), alpine larch (aL), trembling aspen (tA), black spruce (bS), white birch (wB), and ponderosa pine (pP).

4.36 BRUSH COMPETITION

Column 5 on Table 7 refers to the rate of regeneration of deciduous tree species and shrub vegetation following forest harvesting. The ratings are based on soil characteristics, slope, aspect, climate and elevation and indicate the susceptibility of the soil associations to revegetate to brush following harvesting. In general, brush competition is greatest on north-facing lower, and concave slopes because adequate soil moisture is usually present. The three brush competition ratings are as follows:

Low - This rating indicates that site characteristics are such that brush competition does not generally prohibit the establishment of a desirable stand of trees.

Medium - This rating indicates that brush competition delays the establishment and slows the growth of seedlings, but will not prevent the development of a desirable stand of trees.

High - This rating indicates that brush competition is likely to prevent the adequate establishment of desirable stands of trees unless artificial site preparation is undertaken.

4.37 WINDTHROW HAZARD

Windthrow hazard ratings in Table 7 are based on soil characteristics such as texture, soil depth, slope,depth to water table and effective rooting depth, and are considered either individually or in combination.

Other factors important in windthrow hazard but not considered in these ratings are the rooting characteristics of the individual tree species, the age and general condition of the stand, exposure to prevailing winds and storm tracks and the extent of exposed forest edge after harvesting (cut block design). Stand density and disease conditions of the trees are other considerations influencing site specific windthrow-hazard ratings.

Three ratings are given:

Low - The effective rooting depth is greater than 100 cm, the soils are coarse textured, and the slopes are less than 30%.

Medium - The effective rooting depth is between 50 and 100 cm, the soils are medium to fine-textured with slopes less than 30%, or the soils are coarse textured with slopes greater than 30%.

High - The effective rooting depth is less than 50 cm in soils of any texture and slopes are generally greater than 30%.

Table 7: Soil interpretations for forestry

Soil Association	% Slope	Potential Capability Classes	Species Associated with Capability Class	Natural Regeneration Potential	Limits to Natural Regeneration Potential	Natural Regeneration	Brush Competition	Windthrow Hazard	Relative Susceptibility of Soil to damage by disturbance	Type of Soil damage by disturbance
Avis	2-15	1f-1	bCo	L	3)	bCo	M 5)	L-M	M	1
Badshot	> 30			L	2,7,8, 11			H	H-M	6,7
Beaton Creek	> 30		es	H	7,11,12	es,e1f	L	H	H	6,7
Beatrice	> 30		es,e1f	L	7,11,12	e1f,es	L	H	H	6,7
Bergman	> 30		D,1P	H	11,12		L	H	H	6,7
Big Fish	30-60		D,1P	L	2,3,8, 11,12		L	H	M	7
Blaylock	> 30			H	11,12		L	H	H	6,7
Blizzard	> 30		D,1P	H	6,11, 12		L-M	H-M	H	1,6,7
Blue-jaune	> 30		es,e1f	L-M	7,11,12	es,e1f	L	H	H	6,7
Bolan Creek	> 30		D,es	H	4,11,12	D,es, es,e1f	L	H	H-M	6,7
Bonner	30-60		es,e1f	H	7,11,12	es,e1f	L	H	H	6,7
Brennan	30-60		es,e1f	H	11,12	es,e1f, D	L	H	H-M	6,7
Brosse	30-60		es,D e1f	L-M	7,11,12	es,D e1f,1P	L-M	H	H-M	7
Bull Creek	30-60		D,es, 1P	H	4,11,12	es,e1f, D,1P,es	H	H	H	6,7
Bunyan	30-60		es,e1f, 1P	H	7,11,12	es,e1f, 1P	L	H	H	1,2,5
Burditt	> 30		D,es, es	H-M	11,12	es,es	L-M	H	H	6,7
Burn	> 30		es,e1f	L	7,12	es,e1f	L-M	H	H-L	9
Calumity	> 30		D,1P, es	H	4,10	es,e1f, D	L-M	H	H	9,10
Carney	> 30		es,e1f	H	7,10	es,e1f	H	H	H	9,10

Soil Association	% Slope	Potential Capability Classes	Species Associated with Capability Class	Natural Regeneration Potential	Limits to Natural Regeneration Potential	Natural Regeneration	Brush Competition	Windthrow Hazard	Relative Susceptibility of Soil to damage by disturbance	Type of Soil damage by disturbance
Cateract	> 30	2W, 3W 1	D,es	H	2,3,8,11, 12	es,e1f	L	H-H	M	1,2,5, 6,7,9, 10
Carvell	> 30	$\frac{A}{6}$,$\frac{S}{5}$,$\frac{M}{4}$ H, A $\frac{F}{3}$,$\frac{W}{2}$	D,1P	H	2,3,8,11, 12	D,1P	L	H-H	L-M	9
Champion	> 30	3W,4H	es,e1f, 1P	H-L	7	es,e1f	M	H	H	9,10
Cliffy	> 30	5W,6H	es,e1f, 1P	H-L	7	es,1P	M	H-H	H	9,10
Complex	> 30	3W,2S 2W	es,mH, D,1P	H-L	7	es,mH, D,1P	M	H	H	9
Conrad	> 30	6H,5W, 6H	es,1P, e1f	L-M	7	es,e1f, 1P	L	H	H	9
Copper	> 30	2S,2W, 3W,1	D,wH,1P	H-M	6	es,e1f, 1P	L	H-H	H	1,9
Copper-Crown	> 30	3W,4H	es,1P, e1f	H	7	es,e1f, 1P	L	H-H	H-L	9
Coudrey	> 30	5W,4H, 3W,3H	es,1P, e1f	H	7	es,e1f, 1P	L	H-H	H-L	9,10
Couldron	> 30	6H,4H 3W,3H	1P,es	L	9	1P,es, e1f	H	H-H	H	9,10
Curtis	> 30	7E	Hil	L	9	wH,es, e1f	H	H-H	L	3,11
Fairmont	2-15	$\frac{S}{5}$,$\frac{M}{4}$,$\frac{W}{2}$ $\frac{F}{3}$	D,1P	H-H	2,3	D,wH,es 1P,e1f	L-M	L	L	3,11
Frosti-vale	2-15	1,2S, 2W	D,wH	H-M	2,3	D,wH,es 1P,es	H-L	L	L	3,11
Gillies	2-15	6H,3W, 1P,2S	D	L	2,4	wH,es, 1P,D	H	L-M	L-M	3,11
Hasle	2-15	1W,5H	D,wH	L-M	2,4	wH,es, D	L-M	L-M	L	3,11
Hawsly	2-15	6H,4W, 2W,7E	D,1P	L	4	D,1P	L-M	L-M	M-L	1,2,5
Hindmarsh	> 30	$\frac{S}{5}$,$\frac{M}{4}$,$\frac{F}{3}$ 3S	D,1P	H	5,8	D,1P	H-L	L	L	3,11
Kingcome	2-15	3S,4H	es,D 1P	H-H	3	es,e1f, 1P	H-L	L	L	3,11
Kootenay	2-15	1W,2S	D,wH	H	2,4	wH,es	H	L-M	H	3,11
Lisiton	2-15	3S	es,1P	H	1,3	es,e1f, 1P	H	H	H	1,2,5, 6,12
Lumley	2-15	$\frac{S}{5}$,$\frac{M}{4}$,1W 2S	D,wH	H	2,8	wH,D,es 1P	H	H	H	1,2,5, 6,8,12
Mayook	2-15, > 30	$\frac{A}{6}$,$\frac{S}{5}$,$\frac{M}{4}$ $\frac{F}{3}$,$\frac{W}{2}$ 4)	D,1P	L	1,3,8	D,1P	M-	H	M	1,2,4, 5,6,12
Mount Cond	> 30	7E	Hil	L	9	wH,es, e1f	H-M	H	H	9,10
Nanaka	2- 9	7W, 1 3)	bCo	L	5,8			H	H	1,2,3, 8
Rectum	30-60	$\frac{C}{6}$,$\frac{F}{3}$ 6	Hil	L	9	Hil	L	H	H	NA
Rossland	> 30	$\frac{C}{6}$,$\frac{F}{3}$ 6	Hil	L	NA	Hil	L	H	H	NA
Sanmar	> 30	25	es,e1f	M	1u	es,e1f	M-H	H	H	1,2,5, 6,8,9, 10
Sandon	> 30	$\frac{S}{5}$,$\frac{M}{4}$,$\frac{W}{2}$ 6H	es,e1f	H	2	es,e1f	H-H	H	H	1,2,5, 6,8,9, 10
Sentinel	30-60	25,1- 1a	D,wH, 1P	H-H	2,8,10	D,wH, wS	L-M	L	M	1,2,5, 6,8
Slocan	30-60	25,1c, 1b,1a	D,1P, wS	H-H	2,8	D,wH, wS	L-M	L	M	1,2,5 6,8
Spillima-cheen	> 30	$\frac{M}{4}$,$\frac{F}{3}$,$\frac{W}{2}$ 3W	es,e1f 1P	H	1,6,13, 1,3,7	es,e1f	H-H	H	L	1,2,5, 6,8
St. Leon	> 30	2W,2S, 1	es,e1f 1P	H	1,7	es,e1f 1P	H-H	H	H	1,2,5, 6,8,9, 10
Steamboat	15-60	1,1e, 2S	D,wH, wS	H	1,10	wH,es, D,1P, wS	H	H-H	H	1,2,5, 6,8,9, 10
Stobart	30-60	1,1e, 2S	D,wH, wS	H	1,10	wH,es, D,1P,wS	H-H	H	H	1,2,5, 6,8,9, 10
Stubbs	30-60	1,1e, 2S	D,wH, wS	H	1,10	wH,es, D,1P,wS	H-H	H	H-H	1,2,5, 6,8,9,10
Sunbeer	30-60	6H,4W, 6H	es,e1f	H	1,7	es,e1f	H-H	H	H-H	1,2,5, 6,8,9
Spellffe	0-30	$\frac{C}{6}$,$\frac{F}{3}$,$\frac{W}{2}$ 6H	D,1P	L	5,8	D,1P	L	L	L-M	1,2,5
Teak Creek	30-60	7E	Hil	M	NA	Hil	NA	NA	NA	NA
Tehr	30-60	7E	Hil	L	NA	Hil	NA	NA	L	NA
Organic Soils	2- 9	7W	bS	M	NA	bS	L	M	M	NA
Bedrock	> 30	7E	NA	NA	NA	NA	NA	NA	NA	NA

FOOTNOTES

1) Soil damage is high whenever access roads for timber harvesting are built across snowchutes and avalanche tracts.
2) The potential capability ratings are variable due to differences in drainage, texture and type of surficial material.
3) Capability class differences are mainly due to variability of drainage and inundation.
4) The different ratings are due to aspect, slope, erosion and level of lime within the soil profile.
5) These numbers and letters refer to preceeding text under the appropriate heading.
6) When harvesting is done during freeze up.

NA = Not applicable.

Windthrow damage as shown on Plates 23 and 24, results when high velocity winds hit the edge of a forest stand or when the tree rooting system is insufficient or the soil too shallow to adequately anchor the tree. Trees growing on shallow soils are particularly susceptible to windthrow damage.

Plate 23

Plate 24

4.38 RELATIVE SUSCEPTIBILITY OF SOILS TO DAMAGE BY DISTURBANCE

This interpretation indicates the relative susceptibility of the soils to damage by timber harvesting, road and trail construction, slash burning and other disturbances. Damage is caused by disturbances which destroy soil structure, cause compaction, increase erosion and lower fertility. Such disturbances may affect other resources resulting in a loss of timber production, lower water quality and yield, and loss of fish values in streams.

The ratings are based on such factors as soil wetness, soil texture, coarse-fragment content, slope and drainage and indicate the susceptibility of soils and other resources to incur damage.

Generally, alluvial sands and gravels have low to medium susceptibility to damage while those that are silty or clayey have medium to high susceptibility. Soils derived from lacustrine deposits and shallow soils overlying bedrock usually incur high degrees of damage.

Soils derived from glacial till incur varying degrees of damage depending on their characteristics while soils of colluvial origin are moderately susceptible.

The three ratings are as follows:

Low - This rating indicates that soils and other resources are likely to receive only minor damage.

Moderate - This rating indicates that soils and other resources are likely to incur moderate damage.

High - This rating indicates that soils and other resources are likely to incur major damage.

4.39 TYPE OF DAMAGE EXPECTED FROM SOIL DISTURBANCE

The following types of damage relate mainly to soil texture and structure and soil losses by erosion, sedimentation and loss of soil biomass.

The types of damage are:

1) Destruction of soil structure, usually on fine and medium-textured soils;
2) Increased soil compaction on fine and medium-textured soils, especially if disturbed when wet;
3) Decrease in soil organic matter content, especially on gravelly soils;
4) Decrease in soil fertility, especially through intensive cropping, destruction of organic matter and excessive leaching of nutrients;
5) Increased erosion of finer textured soils and on most steeper slopes;
6) Loss of the soil resource by physical removal or erosion, especially shallow soils overlying bedrock;
7) Increased mass-movement hazard, especially on steeper slopes;
8) Disruption of natural drainage patterns;
9) Increased stream sedimentation from medium to coarse-textured soils;
10) Increased stream siltation from silts and clayey soils.

4.4 SOIL INTERPRETATIONS FOR AGRICULTURE

Less than 7% of the Lardeau map area is arable; the rest is steeply sloping and mountainous or has severe climate limitations. Since the 1960's the number of farms has been decreasing steadily in the Arrow Lakes area, partly because of good quality agricultural land being flooded by the High Arrow Dam reservoir.

Land topographically suited for agriculture is scattered throughout the main valleys. It occurs in small pockets near the north end of Kootenay Lake, in the Lardeau and the Incomappleux River valleys, near Slocan Lake and in the Upper Columbia River valley. Plate 25 shows an example of land topographically suited for agriculture.

Plate 25

The agricultural potential in the Upper Columbia River valley is restricted by the limited acreage of arable land. The arable areas are largely confined to some fluvial fans and lacustrine deposits and a few relatively level areas of glacial till deposits.

Forage crops consisting mainly of alfalfa and perennial grasses, together with livestock production form the basis for agriculture in this area. This part of the Rocky Mountain Trench generally contains extensive natural grazing lands, although the overall acreage in the Lardeau map area is small. The carrying capacity on these lands is generally low, but they help to supplement the other, better agricultural lands.

4.41 CLIMATE CAPABILITY FOR AGRICULTURE

Climate constitutes a basic limitation for agricultural crop production regardless of soil conditions. The Lardeau map area, due to its

mountainous terrain, includes a wide variety of climates. These have been categorized according to their ability to support agricultural crops into a series of climate capability classes (see Figure 21). It is apparent from this climate capability map that the better climates for agriculture occur in all main and some tributary valleys (British Columbia Land Inventory, 1972). Table 8 indicates the climatically suited crops that could produce average or better than average yields on the stated soils.

4.42 SOIL CAPABILITY FOR AGRICULTURE CLASSIFICATION

The soil capability classification for agriculture is an interpretive grouping, one of many that can be made from the basic soil survey data and soil mapping units. In this classification (Canada Land Inventory Report, 1965), the mineral soils are grouped into seven classes according to their limitations for agricultural use.

Classes 1, 2 and 3 are considered capable for the sustained production of commonly cultivated crops; Class 4 is marginal for sustained arable agriculture; Class 5 is capable of use only for permanent pasture and hay; Class 6 is capable of use only for natural grazing, and Class 7 consists of soil areas unsuitable for arable culture or grazing.

The capability classification is applied to all soil areas. Research data, recorded observations and experience are used as the basis for placing soils in capability classes and sub-classes. In areas where research information is lacking about certain soils, their capabilities were determined by interpreting soil characteristics on the basis of experience gained on similar soils elsewhere.

The capability ratings are based on the effects of combinations of climate and soil characteristics and their general productive capacity for common field crops. Good soil management practices that are feasible and practical under a mechanized system of agriculture are assumed. Distances to market, type of roads, locations and size of farms, characteristics of land ownership and cultural patterns, as well as the skill and resources of individual operators, are not considered in the capability ratings.

Figure 22 shows the generalized soil capability for agriculture ratings of the Lardeau map area. More detailed maps at scales of 1:125 000 and 1:50 000 are available from the Resource Analysis Branch, Ministry of Environment, Parliament Buildings, Victoria, B.C.

Very small acreages with irrigated Class 1 capability occur as parts of map units in the Arrow Park area. They consist of deep, well drained, medium to fine textured soils with frost-free periods between 120 and 150 days.

Soils rated Class 2 are typically deep, well drained and medium textured, but are slighty limited by low moisture holding capacities and adverse slopes. The Lawley and Gillis soils near Arrow Park, along Arrow Creek, southwest of Nakusp and near Brouse are rated Class 2. Topography and climatically suited, medium-textured portions of Avis Soil Association mainly located in the Lardeau and Incommappleux River valleys, are also rated Class 2 (irrigated). Some Fairmont soils in the vicinity of Invermere and Radium as well as parts of the Nowitka soils are Class 2 as well.

Class 3 (irrigated) soils are generally deep, well or rapidly drained and often coarse textured. The usual limitations for agricultural use are low moisture holding capacities, danger of inundation or adverse climate. They mostly occur on glacio-fluvial terraces and adjacent lands near Arrow Park, Galena Bay, Lardeau River and Nakusp. They also occur on parts of the floodplains of the

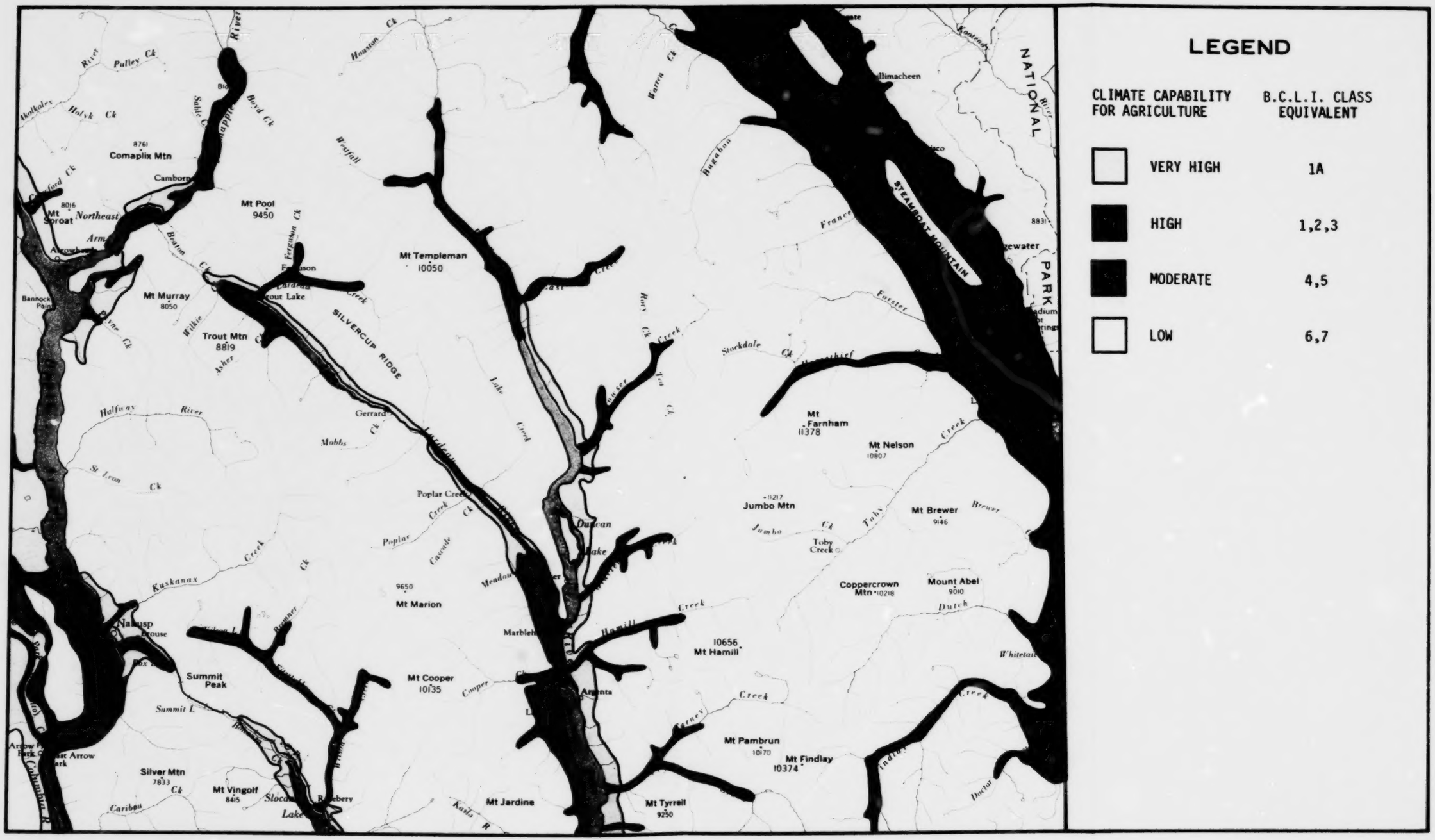


Figure 21: Generalized climate capability classes for agriculture of the Lardeau map area

Table 8: Crop suitability for soils of the Lardeau map area

CROP	SOIL	CLIMATE* CAPABILITY CLASS	FROST-FREE* PERIOD	GROWING DEGREE* DAYS (>42°F)
Hardy tree fruits (apples, pears, cherries, crabapples), corn, tomatoes and peppers	Deep well drained, medium to coarse textured soils, free of impervious layers and lime. Lawley, Avis, Gillis, Kaslo and Fruitvale soil associations.	1a and higher (crabapples in class 1 and higher)	120-130 days (90-120 days)	2500-3000 (2150-2600)
Cereal grains such as wheat, oats and barley have fine fibrous roots)	a) for wheat: deep, well drained and medium textured soils of the Avis and Lawley associations	2 and higher	75-90 days	1900-2150
	b) for oats and barley: deep well drained, medium to fine textured soils of the Avis and Lawley associations	3 and higher	60-75 days	1650-1900
Vegetables for transplantation such as broccoli, brussel sprouts, cabbage, celery and onions; also radish, corn, spinach and parsley	Soil depths are a minimum of 10-18 in., loamy sand to silty clay loam overlying either impervious layers, gravels or bedrock. Best suited soils are Avis, Lawley, Gillis, Mayook and Nowitka associations**	3 and higher	60-75 days	1650-1900
Deep rooted vegetables such as asparagus, turnip, parsnip, horseradish, beet, carrot	Soil depths are greater than 18 in., loamy sand to silty clay loam overlying either impervious layers, gravels or bedrock. Best suited are Avis, Lawley, Gillis, Mayook and Nowitka associations**	3 and higher	60-75 days	1650-1900
Forage Crops. The characteristics of grass and legume species and varieties is not specific. Climatic and soil factors may greatly vary growth response to any soil condition. a) Orchard grass, brome grass, timothy, ryegrass and legumes such as alfalfa and red clover	a) Deep, well and imperfectly drained, moderately stony soils of the Avis, Nowitka, Fruitvale, Lawley, Mayook and Fairmont associations**. The following have various soil limitations and may be suitable for crops indicated: Carney, Cataract, Cooper, Coppercrown, Kaslo, Keeney, Kinbasket, Kingcome, Kuskanax, Linten, Sentinel, Slocan, Spillimacheen, Steenhoff, Stobart, Stubbs and Wycliffe associations	5 and higher	30-50 days	1200-1650
b) Reed canary grass, timothy grass and alsike clover	b) Imperfectly and poorly drained members of the Avis and Nowitka associations	5 and higher	30-50 days	1200-1650

Footnotes: *Climatology Report #1, 1972.

**Soils may have no excess water or strongly sloping topography. Detailed soil investigation is needed to assess stoniness, texture and topography for crop suitability.

Duncan River, and on lacustrine derived soils on the east side of the Upper Columbia River between Spillimacheen and Invermere.

Class 4 (irrigated) soils, limited by adverse climate, stoniness, poor drainage and/or topography occur in the vicinity of Fosthall, Nakusp, Hills, and Argenta. Some fluvial fans (Fairmont soils) between Invermere and Spillimacheen are also Class 4.

Class 5 (irrigated) soils generally derived from stony, coarse-textured glacial till, are found in areas of colder climate and on steeply sloping topography. Substantial acreages occur west of the Columbia River northwest of Radium and also near Hills, Galena Bay and south of Nakusp.

Almost 93% of the Lardeau map area consists of Class 6 and 7 soils (dryland rated). These are basically non-agricultural soils, but some natural grazing is possible on Class 6 soils. Severe climate, steep topography and rockiness are the main limiting factors.

Plates 26 and 27 show two areas near Nakusp where farming is taking place on a small scale.

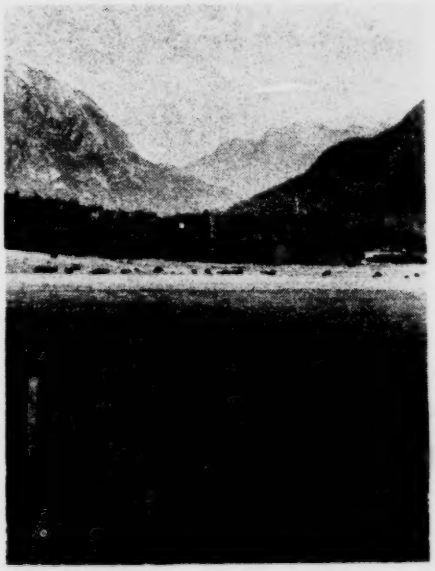


Plate 26

Plate 27

4.5 EXTENSIVE AND INTENSIVE RECREATION OF THE LARDEAU MAP AREA

4.51 EXTENSIVE RECREATION CAPABILITY OF THE LARDEAU MAP AREA*

Three fairly large lakes, Upper Arrow, Trout, and Duncan, and parts of Windermere, Kootenay, and and Slocan lakes are found in the Lardeau map area and offer a wide range of shore-based recreation. These long, narrow lakes are situated between rugged, scenic mountains, which often rise abruptly from the water's edge to elevations of over 8000 feet. Consequently, most of the shoreline, although scenic, is too steep for intensive recreational activities. However, mountain creeks entering the lakes have created many flat, rapidly drained fluvial fans that are well-suited for camping, boat-launching, angling, and water sports. Some of these sites, such as on Arrow Lake, have high quality sand beaches, but swimming and bathing are limited by cool water temperatures. An exception is Lake Windermere where

* By D.R. Benn, Canada Land Inventory Recreation Capability Report Map Area 82K, 1968.

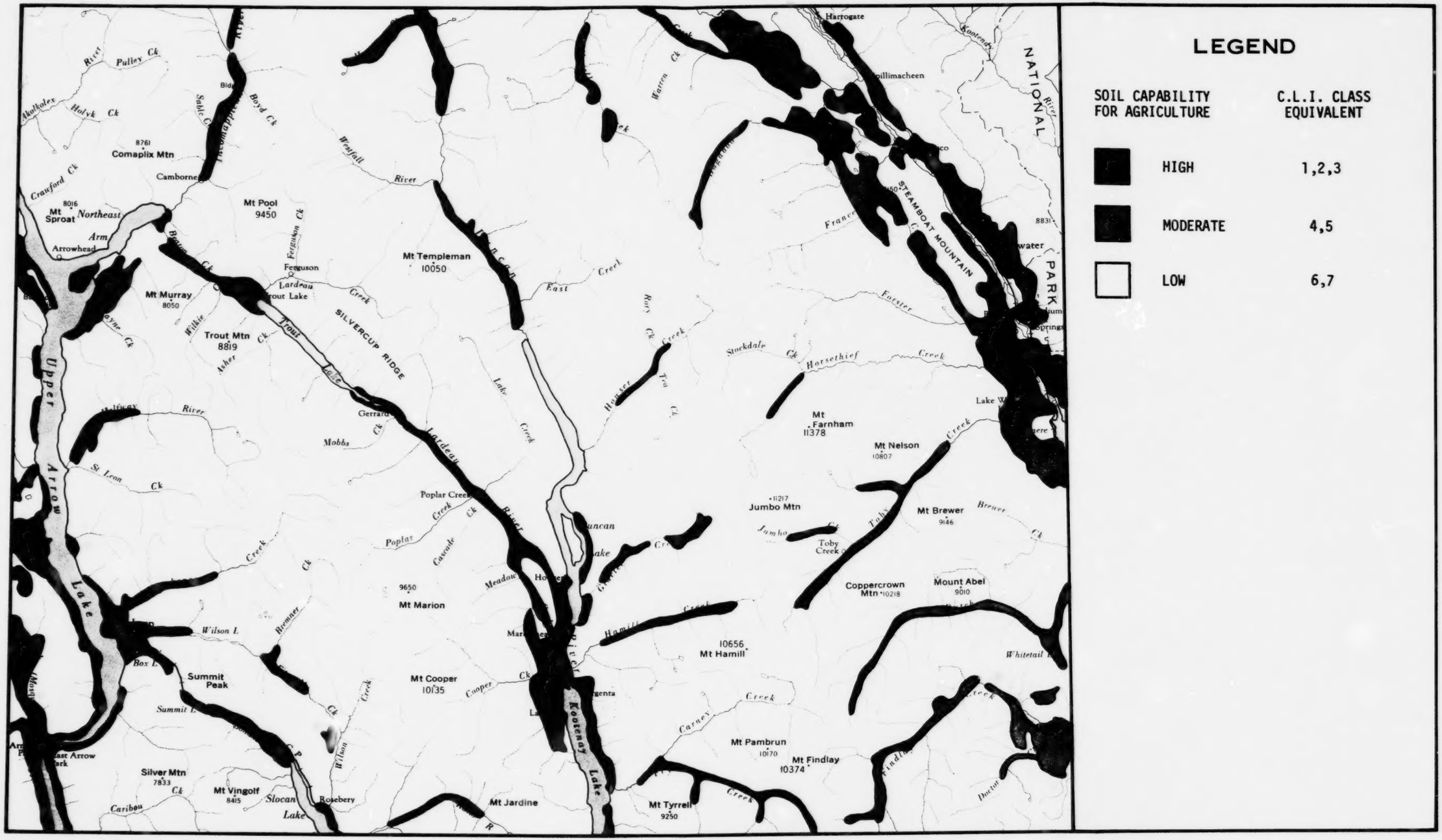


Figure 22: Generalized soil capability classes for agriculture of the Lardeau map area

the shallow waters become relatively warmer during the summer. The configuration of all the lakes tends to create wind conditions which are sometimes hazardous to boaters.

Some special features of the lakes include driftwood beaches, protected bays, and good fishing for trout and char on Upper Arrow Lake; frequent and continuous sand beaches with a scenic mountain wilderness background around Slocan Lake; outstanding views of glaciers, observation of spawning fish in season, and good angling at Trout Lake; excellent fishing and scenic viewing on Kootenay Lake (see Plate 30); good fishing and excellent mountain scenery at Duncan Lake; and warm water temperatures and waterfowl concentrations at Lake Windermere.

The many rivers and creeks that drain the area provide potential access and scenic corridors to points of interest throughout the region. Potential for camping and angling is good on all the large streams. The Lardeau River is especially attractive for camping and has an exceptional capability for viewing spawning trout, kokanee, and char (see Plate 31). The upper reaches of the Duncan River offer opportunities for streamside camping in a mountain setting.

The streams that drain the eastern slopes of the Purcell Mountains, such as the Spillimacheen River and Bugaboo, Forster, Horsethief and Toby creeks, are situated in broad scenic valleys. Perhaps the best example is Bugaboo Creek, which features camping along a scenic corridor and easy access to dramatic mountain and glacier views. Further south, Dutch and Findlay creeks offer attractive campsites with stream fishing. Whitetail Lake, located between these two drainages, has opportunities for cottaging, boating, angling and swimming.

Alpine meadows and mountain scenery are important features of the area. Two major sites, both in the Purcell Mountains, are Bugaboo Glacier (Plate 28 below) and Lake of the Hanging Glacier, which have outstanding viewing potential. Opportunities for expert skiing are abundant in the high mountains and on glaciers where skiers may take advantage of summer snow conditions.

Plate 28

The Selkirk Mountains are more subdued and have fewer alpine meadows and viewing opportunities. The Hamling Lakes near Nakusp are particularly scenic and consist of about ten small tarns located at high elevations and surrounded by alpine meadows.

The floor of the Rocky Mountain Trench has a high capability for extensive activities such as fishing, hiking, riding, camping, cross country skiing, viewing of waterfalls and canyons and gathering and collecting rocks along the creeks that enter the Trench from the Purcell Mountains. Observing waterfowl, canoeing on the Columbia River, and cottaging along the shoreline of many small upland lakes are other potential activities in this part of the Lardeau map area.

4.52 SOIL INTERPRETATIONS FOR INTENSIVE RECREATION

Decisions relating to the establishment and development of recreation facilities can be considered at three levels:

a) The identification of the area to be used for recreation, based generally on demand and aesthetic or unique landscape features, or both.

b) The assessment of landscape and soil parameters in the area to provide the required information for broad planning and location of recreation facilities.

c) Site specific interpretations, based on engineering considerations, for facilities.

In this discussion only the second level will be covered. Such factors as aesthetics, accessibility and demand are not considered here. Site specific interpretations are dealt with by other groups.

The suitability (or limitations) of the land for recreational use is a function of the soil properties in conjunction with topographic and other landscape parameters. Decisions, however, to develop areas are often determined by factors other than those of the soil or landscape. It is especially important, therefore, to assess, at the planning level, all areas at a broad scale so that the consequences of decisions to develop specific areas can be evaluated.

1. Landscape Parameters

Some landscape parameters which should be considered in the location of recreation developments are:

- potential mass movement hazard
- potential (or actual) avalanche hazard
- flood hazard
- regional and local ground water regime
- general ecological uniqueness and sensitivity.

2. Soil Parameters

The following interpretations (Table 9) pertain to recreational development and are based on soil and bedrock properties, soil drainage, landforms or surficial deposits, topography and vegetation.

Fine-textured soils (high in silt and clay content) are subject to puddling and compaction when wet, and tend to become sticky and slippery. These soils also dry slowly after wetting. Silty soils also become dusty when dry. Generally, fine-textured soils can be expected to present development problems where buildings, playgrounds, and path and trail development or a combination of these is proposed.

Coarse textured, droughty, soils present difficulties for some uses. On these, grass cover is hard to establish and maintain, and roads may be dusty. In sandy areas, vehicle traction may be poor and wind erosion may be a problem when natural grass and vegetative cover is removed.

Shallow soils underlain by bedrock have limitations for the building of structures, roads and trails, and septic tank disposal facilities. Very stony or rocky soils have severe limitations for use as playgrounds and campsites.

Steep slopes limit the use of soils, although some of the limitations can be overcome by levelling for campsites and building sites if the cost of doing so is justified.

Sanitary facilities are essential for recreational areas. It is important to assure adequate septic tank disposal facilities for effluent. Fine textured soils, especially those in wet areas, present problems due to low percolation and poor soil drainage. Coarse

textured soils may serve disposal purposes well, but if open water is nearby, contamination is likely.

Soils most suitable for sewage effluent disposal have textures of silt loam or sandy loam. They should have gentle slopes and be deep with no layer that restricts water movement. The inferred soil characteristics and measured soil properties which should be considered when rating land for recreational use are listed below. Their significance varies among regions.

Soil limitations for a number of recreational uses of the land are listed in following table and are classified into five categories:

None - This rating indicates that the soil has no limitations for a particular use.

Slight - This rating indicates that the soil is suitable for a particular use and any limitations are easily overcome.

Moderate - This rating indicates that limitations exist which may be overcome by good planning, careful design and good management. Some of these moderate limitations result from the effect of slope, wetness, soil texture, soil depth, plant growth deficiencies and stoniness.

Severe - This rating indicates that soil limitations are such that development should not be considered unless major reclamation under careful supervision is proposed. Soil limitations result from the effects of steep slopes, high water tables, stream flooding, unfavourable soil texture, and very large numbers of rocks and stones.

Very severe- This indicates that soil limitations are such that no development should be considered.

It should again be emphasized that the interpretations in Table 9 provide a "soil foundation" on which to plan, locate and build recreational facilities. The criteria used to establish limitations for the interpretations shown in the column of Table 9 are given in the Appendix (Montgomery et al, 1966).

4.521 Intensive use camp and picnic areas

The most suitable soils for camping and picnicking areas are well-drained, level to gently sloping, moderately permeable, medium to coarse textured, and are not influenced by seepage or ground water. They should also be relatively stone-free at the surface. Plate 29 shows a typical example of soils suitable for camping and picnicking areas.

Plate 29

Table 9: Soil limitations for selected intensive recreational uses

SOIL PARENT MATERIAL	SOIL ASSOCIATION SYMBOL AND COMPONENT	CAMP AND PICNIC AREAS	INTENSIVE PLAY AREAS	BUILDING AND COTTAGING SITES	PATHS AND TRAILS	ECOLOGICAL DAMAGE HAZARD	SOIL FEATURES AFFECTING USE
Recent fluvial deposits (Regosols)	AS_1,AS_3,AW_1,AW_3	Moderate	Moderate	Slight	Slight	Slight to moderate	Variable permeability, some surface stoniness
Recent fluvial deposits (Gleysols)	AS_2,AS_{4-6},AW_2,AW_5	Severe	Severe	Severe	Moderate	Moderate	Flooding hazard, seasonally higher water table
Very shallow colluvium (<20") derived from or overlying bedrock	BS_3,BA_5,BC_4,BT_6, BZ_6,BT_5,BX_6,BQ_6, BB_5,BE_5,BH_6,BP_5	Very severe	Very severe	Severe	Severe	Severe	Extreme shallow soil overlying bedrock, steeply sloping
Shallow colluvium (<5") derived from or overlying bedrock	BS_{1-2},BA_{1-4},BC_1, BC_3,BB_{1-2},BF,BY_{1-4}, BZ_{1-5},BT_{1-4},BX_{1-4}, BX_6,BQ_{1-3},BB_{1-4}, BE_{1-4},BH_{1-5},BP_{1-4}, BP_6,BH,BV_{1-3}	Severe	Severe	Severe	Moderate to severe	Moderate to severe	Shallow soil overlying bedrock, generally steeply sloping
Deep colluvium with coarse grained rock fragments	CP,CX,CC,CF	Severe	Severe	Severe	Moderate	Moderate	Generally steep topography and often unstable slopes, stony and bouldery surface
Deep colluvium with medium and fine grained rock fragments	CL,CY,CE,CR,CH, CH,CB,CW	Severe	Severe	Severe	Moderate	Moderate	Steep topography often unstable and bouldery surface
Colluvium present on snowchutes and avalanche tracts	CS,CT	Very severe	Very severe	Very severe	Moderate to severe	Moderate	Avalanche hazard, erosion on trail may occur
Fluvial fans (without seepage)	FA_{1-3},FT_2	None to slight	Slight to moderate	Moderate	None	Slight	Variable texture and stoniness on surface
Fluvial fans (with seepage)	FA_4,FT_1,FT_3	Moderate	Severe	Severe	Moderate	Moderate	Slightly wetter and may have seepage as above
Sandy glaciofluvial deposits	GS	None to slight	Moderate	None to slight	None	Slight	Difficult to establish vegetation; subject to wind erosion
Gravelly and sandy glaciofluvial deposits	XO,XE,XG,XX	Slight to moderate	Moderate to slight	Slight (except near edge)	None to slight	None	Steep topography near edge, may cause slumping
Lacustrine deposits	LY,LL,MY	Moderate to severe	Severe	Moderate to severe	Slight	Moderate	When wet, soils are slow to dry out and are muddy; dusty when dry
Shallow colluvium overlying or derived from bedrock	RA,RL	Severe	Severe	Severe	Moderate	Severe	Fragile alpine environment
Glacial till with coarse grained stone fragments	SH,SR,SH	Moderate to severe	Severe	Moderate to severe	Moderate	Moderate to severe	Steep topography, some compaction and erosion
Glacial till with medium and fine grained stone fragments	SL,SB,SF,SA,SP SD,ST	Severe	Severe to very severe	Severe	Moderate	Moderate	Steep topography, moderate erosion potential, some compaction
Drumlinized glacial till	XB,MY	Slight to moderate	Moderate	Slight	Slight	Slight	Moderate topography
Talus cones	TR,TK	Very severe	Very severe	Very severe	Moderate to severe	Severe	Erosion can occur and ravelling of boulders

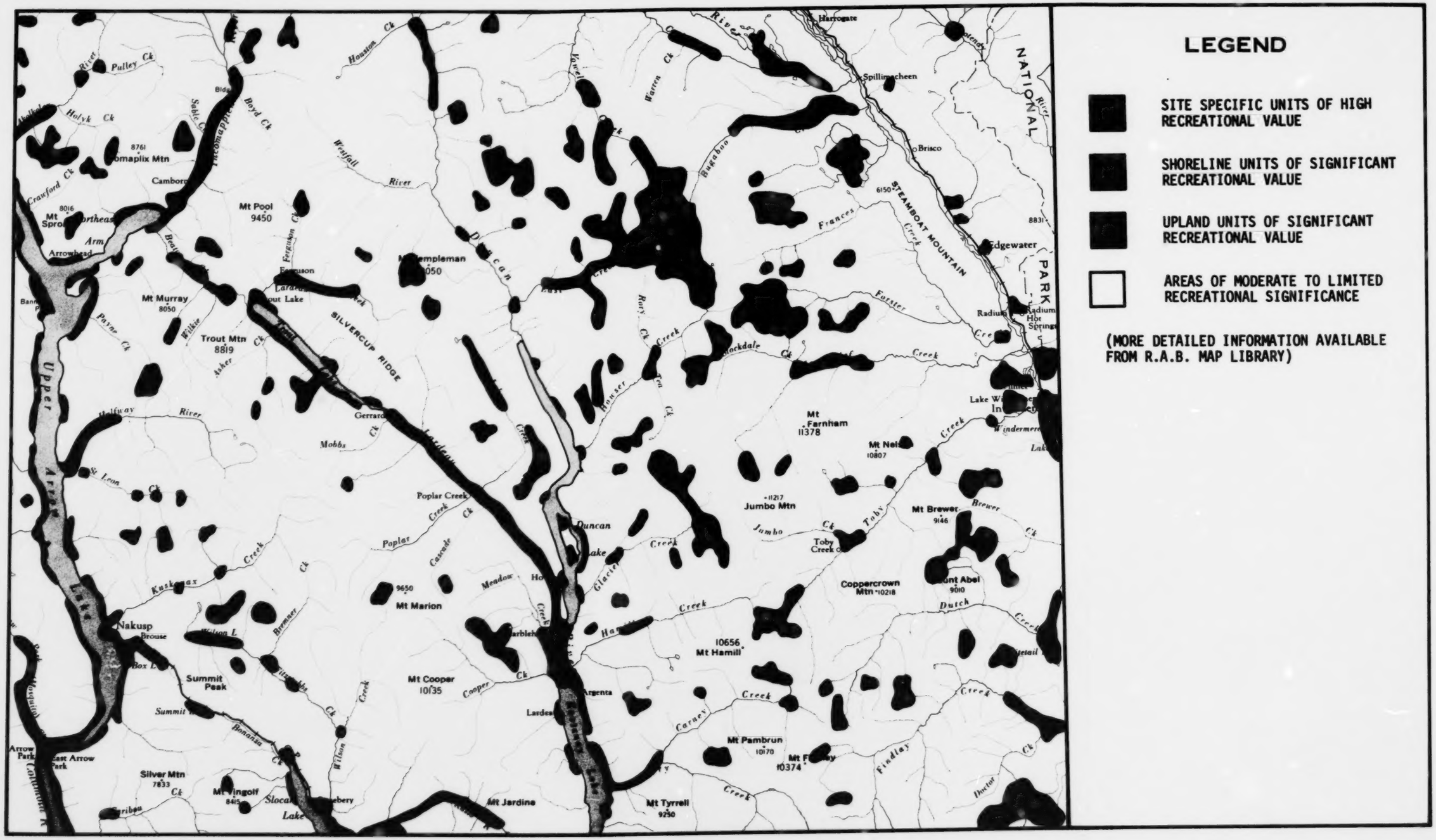


Figure 23: Generalized recreation capability classes and features of the Lardeau map area

4.522 Intensive use play areas (playgrounds)

Soil characteristics suitable for playgrounds are similar to those for camping and picnic areas. The soils should be deep, have rapid permeability, none to very gentle slopes and be stone and rock free. They should also be relatively coarse textured (i.e. not sticky or slippery).

4.523 Soil limitations for building sites and cottaging in recreational areas

The reader is referred to the Engineering section of this report for more precise information concerning the suitability of soil parent materials. Individual on-site investigations are recommended for any building site.

4.524 Soil limitations for paths and trails

The ratings apply to establishing and maintaining paths and trails in non-intensive areas. The most suitable soils are not subject to flooding, seepage, and erosion.

4.525 Ecological damage hazard

This interpretation pertains to the susceptibiity to damage of the soils and vegetation by recreational activity. Fragile environments such as alpine areas are easily damaged by even moderate use.

4.6 WILDLIFE DISTRIBUTION AND HABITAT OF THE LARDEAU MAP AREA*

A wide variety of wild ungulate species are found in the Lardeau map area, reflecting the diverse topography, climate, soils and vegetation which provide the necessary habitats of the different species. In specific regions of the map area certain species predominate because of their special habitat requirements.

Seven wild ungulate species occur in the map area. They are: mule deer (Odocoileus hemionus), whitetail deer (Odocoileus virginianus), Rocky Mountain elk (Cervus canadensis), moose (Alces alces andersonii), mountain caribou (Rangifer tarandus), mountain goat (Oreamnos americanus) and Rocky Mountain bighorn sheep (Ovis canadensis).

Winter ranges of all ungulates, except goats and caribou, occur in the major valley bottoms. The Rocky Mountain Trench contains the greatest amount, the Duncan-Kootenay Lake valley contains the second highest amount, and the Arrow Lakes basin contains the third highest amount of high capability winter range. Mountain goats and mountain caribou generally winter at higher elevations. The mountain caribou winter within the Engelmann spruce - alpine fir forest zone and on the marshy alluvial habitat of the Duncan River valley. Mountain goats winter within the Engelmann spruce - alpine fir forest zone as well as on exposed rocky ridges.

The map area can be subdivided according to the distribution of mountain sheep, mountain caribou, moose and elk. Correlations exist between climate and physiography and in turn, vegetation and the distribution of these four ungulate species.

* By D. Demarchi, Wildlife Biologist, Resource Analysis Branch, Ministry of Environment, Parliament Buildings, Victoria, B.C.

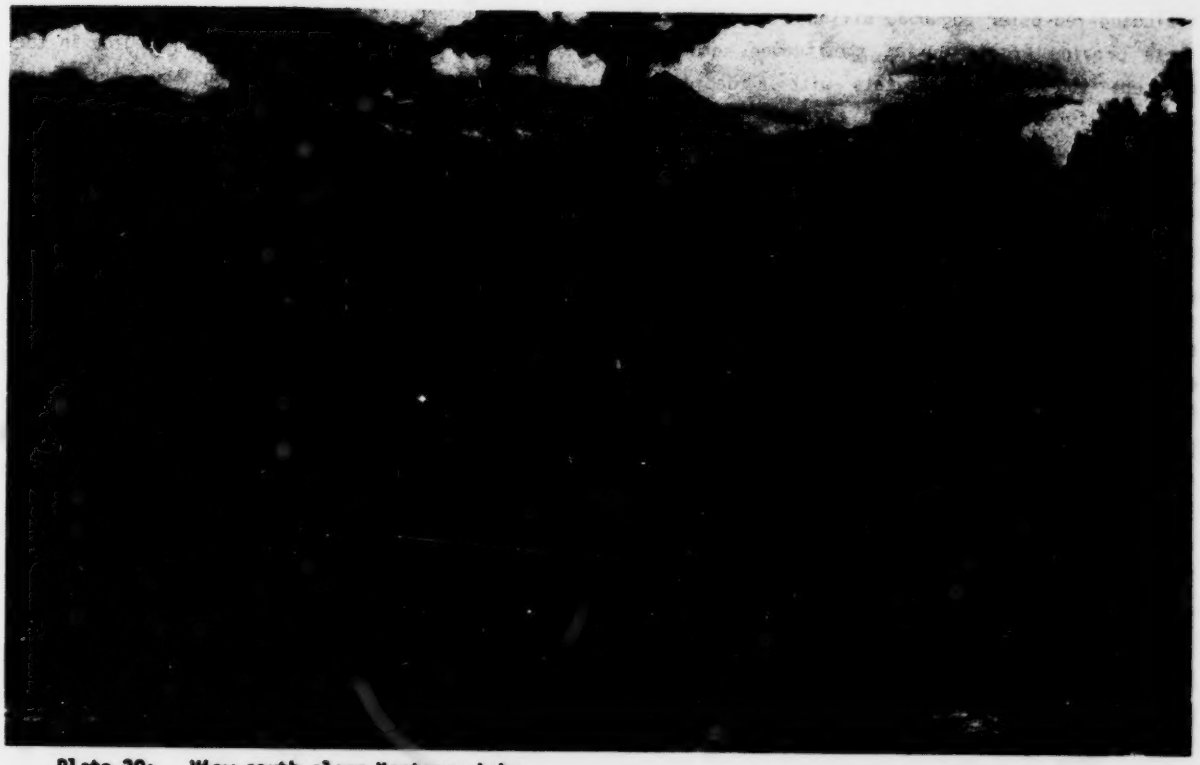


Plate 30: View south along Kootenay Lake

Mountain goat, mule deer and whitetail deer can exist in a variety of habitats and thus are found in various environments in the map area.

Mountain sheep in the map area are found only in the Rocky Mountains and on the upper, west facing slopes of the Rocky Mountain Trench where calcareous soils predominate. The alkalinity of these soils, coupled with arid summer climates favours the production of bluebunch wheat grass, Idaho fescue and pinegrass, making it the only area where bighorn sheep can winter.

Mountain caribou occur only in the Selkirk Mountains where the general relief is relatively subdued. Alpine vegetation for summer forage and lichen bearing western hemlock and western red cedar for winter forage are present. Some mountain caribou also winter at the lower elevations in areas where marsh vegetation is not too deeply covered by snow.

Rocky Mountain elk are generally found where the caribou are absent. Elk are distributed from the Rocky Mountains to the Duncan-Kootenay Lake basin and on the south-facing slopes of the Slocan Ranges. Elk appear to be limited by the lack of winter ranges in the western part of the map area. They require bunch grasses or sedges for winter forage and can tolerate only moderate snow depths. The Douglas-fir forest of the Rocky Mountain Trench and the (poorly drained) Columbia River floodplain provide the best areas for these types of vegetation. Few high capability winter range areas are available in the western hemlock-western red cedar forest zone. Some are present in the leeward valleys of the Selkirk Mountains, primarily in the Duncan-Kootenay Lake basin and adjacent to Slocan Lake.

Moose occur primarily east of the Purcell Mountains and on the west side of Upper Arrow Lake. The areas adjacent to the Rocky Mountain Trench produce the best browse vegetation,

including red-osier dogwood, willow and wild rose. These provide browse during the summer, and are adjacent to riparian habitats with a deciduous alluvial forest typified by presence of black cottonwood and balsam poplar overstory for winter range. The absence of moose in the Duncan valley indicates an apparent lack of availability of summer range.

Whitetail deer are restricted to the bottoms of the major valleys within the map area. They are most abundant in the Rocky Mountain Trench and Duncan River valley, but they also occupy the gentle south-facing slopes adjacent to riparian habitats in the Arrow Lake basin. They are found in either the Douglas-fir or deciduous alluvial forest during the summer, where they feed on the leaves of saskatoon, red-osier dogwood, willow and rose. In the winter they are restricted to areas of shallow snow with evergreen vegetation such as Oregon grape, kinnikinnick species, Douglas-fir and pussytoes.

Mule deer are distributed throughout the map area. They are not restricted to any region in the summer period. However, during the winter are restricted by snow depth and consequently they are most abundant in the major valley bottoms. The Rocky Mountain Trench has the best wintering habitat, the Duncan-Kootenay Lake valley the second best, and the Arrow Lake basin third. In these areas the mule deer concentrate on the south and west-facing slopes where the snow cover is reduced and browse species such as saskatoon, yellow-stem ceanothus, willow, false box, Oregon grape and phlox are abundant.

Rocky Mountain goats are distributed throughout the mountains in the map area. They generally occupy areas of steep terrain at or near timberline where they feed on alpine vegetation all year. During the winter they require areas with light snow cover to obtain forage. Consequently they are concentrated on wind-swept timberline slopes and on rocky areas where some forage is available.

Plate 31: The Lardeau River

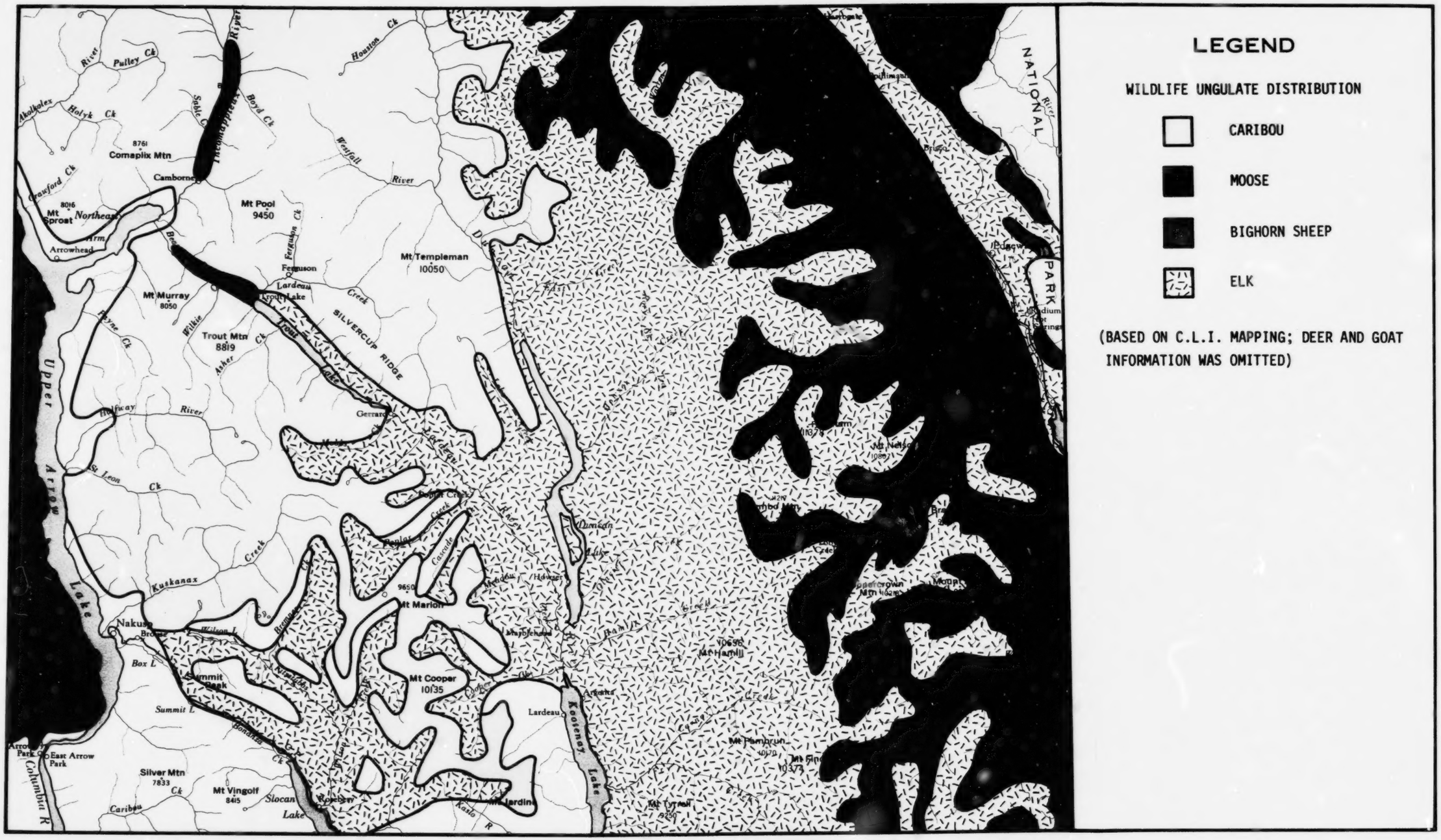


Figure 24: Generalized wildlife ungulate distribution in the Lardeau map area

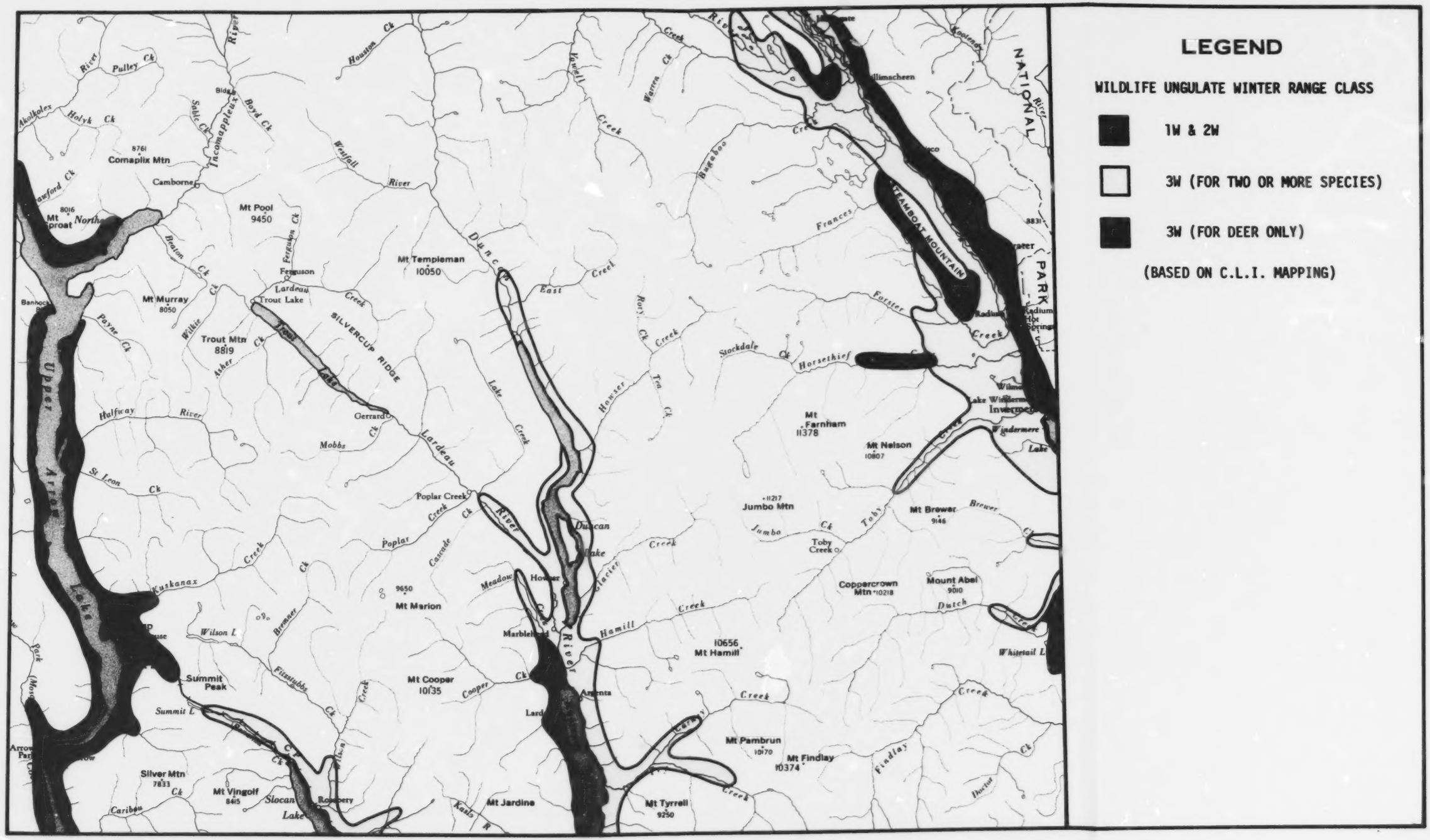


Figure 25: Generalized wildlife ungulate winter ranges in the Lardeau map area

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GLOSSARY OF TERMS IN SOIL SCIENCE

GLOSSARY OF TERMS IN SOIL SCIENCE*

AASHO - Classification (soil engineering) - the official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

AEOLIAN DEPOSIT - Material deposited by wind; includes loess and dune sand.

AGGREGATE - A group of soil particles cohering, so as to behave mechanically as a unit.

ALLUVIAL DEPOSIT - Material deposited by moving water.

ASSOCIATION (Soil) - A group of closely interrelated soil series developed on similar parent materials and under essentially similar climates. A similar climatic condition is taken to include only one forest zone.

AVAILABLE NUTRIENT - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

AVAILABLE SOIL WATER - The portion of water in a soil that can be readily absorbed by plant roots; generally considered to be that water held in the soil against a pressure of up to approximately 15 atmospheres.

BASE SATURATION - The extent to which the absorption complex of a soil is saturated with exchangeable cations other than hydrogen and aluminum.

BEDROCK - The solid rock that underlies soil and the regolith or that is exposed at the surface.

BOG - General term for permanent wet land with low bearing strength.

BOULDERS - Stones larger than 24 (60 cm) inches in diameter.

BULK DENSITY - The weight of ovendry soil (105°C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

CALCAREOUS SOIL - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with 0.1 N hydrochloric acid.

CAPABILITY CLASS - (soil), a rating that indicates the general capability of a soil for some specified use. It is a grouping of lands that have the same relative degree of limitation or hazard. This limitation becomes progressively greater from Class 1 to Class 7.

CAPABILITY SUBCLASS - (soil), A grouping of soils that have similar kinds of limitations and hazards. It provides information on the kind of conservation problem or limitation. The class and subclass together provide information about the degree and kind of limitation for broad land use planning and for the assessment of conservation needs.

CARBON-NITROGEN RATIO (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or organic material.

CATION EXCHANGE CAPACITY (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

CLAY - As a soil separate, the mineral soil particles less than 0.002 mm in diameter; usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

* taken from Canada Department of Agriculture, 1972.

COARSE FRAGMENTS - Rock or mineral particles larger than 2 mm in diameter.

COBBLES - Rock fragments 3 to 10 inches in diameter.

COLLUVIUM - A deposit of rock fragments and soil material which has accumulated on or at the base of steep slopes as a result of gravitational action.

COLOUR - Soil colours are compared with a Munsell colour chart. The Munsell system specifies the relative degress of the three simple variables of colour; hue, value and chroma. For example: 10 YR 6/4 means a hue of 10 YR, a value of 6, and a chroma of 4.

COMPLEX (soil) - Two or more soil units that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

CONDUCTIVITY, ELECTRICAL - A physical quantity that measures the readiness with which a medium transmits electricity. It is expressed as the reciprocal of the electric resistance (ohms) or mmhos per cm at 25° C of a conductor which is one cm long with a cross sectional area of one square cm. It is used to express the concentration of salt in irrigation water or soil extracts.

CONSISTENCE (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

CONTINENTAL CLIMATE - A general term for the typical climate of great land masses where wide ranges in temperature and other weather conditions occur, because the area is not under the influence of large bodies of water.

CONTOUR (line) - A line on the map showing equal height above sea level.

DEFLOCCULATE - To separate or to break up soil aggregates into individual particles.

DEGRADATION - The changing of a soil to a more highly leached and weathered state usually accompanied by morphological changes such as the development of an eluviated, light coloured A (Ae) horizon.

DEGREE DAY - A degree day is defined as the number of degrees which the mean daily temperature is above 42° F.

DELTA - An alluvial or glaciofluvial deposit at the mouth of a river that empties into a lake or sea.

DRAINAGE (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

DRIFT - Material of any sort deposited in one place by ice after having been moved from another. Glacial drift includes all deposits whether stratified or not.

DRUMLIN - An elongated or oval hill of glacial drift, commonly glacial till, deposited by glacial ice and having its long axis parallel to the direction of ice movement.

DRYLAND FARMING - The practice of crop production in low rainfall areas without irrigation.

DUFF - A common term for surface organic layers, developed under imperfectly to well-drained conditions.

ECOLOGY - The study of the relationship between living organisms and their environment.

EDAPHIC - (1) Pertaining to the soil, (2) Resulting from or influenced by factors inherent in the soil or other substrate rather than by climatic factors.

ELUVIAL HORIZON - A soil horizon from which material has been removed in solution or in water suspension.

EROSION - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind, ice or other geological agents such as gravity induced downslope movement of materials.

EVAPOTRANSPIRATION - The combined loss of water from a given area during a specific period of time by evaporation from the soil surface and by transpiration from plants.

FAN - A fan-shaped deposit of outwash at the toe of a slope where a tributary valley enters a main valley.

FERTILITY (soil) - The status of a soil with respect to the amount and availability of elements necessary for plant growth.

FINE TEXTURE - Consisting of or containing large quantities of fine fractions, particularly silt and clay.

FLOODPLAIN - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

FLUVIAL DEPOSITS - Materials laid down by recent streams and rivers.

FRIABLE - A consistence term pertaining to the ease of crumbling of soils.

FROST ACTION - Freezing and thawing of moisture in materials and the resultant effects on these materials and on the structures of which they are a part or with which they are in contact.

FROST FREE PERIOD - The average number of days between the last spring temperature of 32° F and the first fall temperature of 32° F.

FROST HEAVE - The raising of a surface, caused by ice in the underlying soil.

GENETIC - Resulting or produced by soil-forming processes.

GLACIAL TILL - Unsorted and unstratified materials deposited by glacial ice.

GLACIOFLUVIAL DEPOSITS - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

GLEYED SOIL - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling, or both, in some horizons than the associated well-drained soil.

GRAVEL - Rock fragments .08 inch to 3 inches in diameter.

GROUNDWATER - Water in the soil beneath the soil surface, usually under conditions where the pressure in the water is greater than the atmospheric pressure and the voids are completely filled with water. Also water that is passing through or standing in the soil and the underlying strata.

GROWING DEGREE DAYS - The number of cumulative degrees above 42° F during the growing season.

HABITAT - The natural environment of an organism.

HORIZON (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

HORIZON BOUNDARY - Boundaries in distinctness and in surface topography. The distinctness depends partly on the contrast between the horizons and partly on the width of the boundary itself.

HUE - One of the three variables of colour caused by light of certain wavelengths and changes with the wavelength.

HUMUS - That more or less stable fraction of the soil organic matter remaining after most of the added plant and animal residues have decomposed.

ILLUVIAL HORIZON - A soil horizon in which material carried from an overlying layer has been precipated from solution or deposited from suspension. The layer of accumulation.

INCLUSION - Soil types found within a mapping unit which are not extensive enough to be mapped separately or as a part of a soil complex.

INFILTRATION - The downward entry of water into the soil.

INTERGRADE - A soil that possesses moderately well developed distinguishing characteristics of two or more genetically related taxa.

IRRIGATION - The artificial application of water to the soil for the benefit of growing crops.

KAME - An irregular ridge or hill of stratified glacial drift deposited by glacial meltwater.

LACUSTRINE DEPOSITS - Material deposited by or settled out of lake waters and exposed by either lowering of the water levels or raising of the land. These sediments range in texture from sand to clay and are usually varved (layered annual or rhythmite deposits).

LANDFORM - Landforms are defined in terms of their size, shape, and slope pattern; the subsurface materials of which they are composed, and their mode of origin or genesis.

LEACHING - The removal from the soil of materials in solution.

LIQUID LIMIT (upper plastic limit) - (1) The water content corresponding to an arbitrary limit between the liquid and plastic states of consistence of a soil. (2) The water content at which a pat of soil cut by a groove of standard dimensions, will flow together for a distance of 12 mm under the impact of 25 blows in a standard liquid limit apparatus.

LOESS - Material transported and deposited by wind and consisting of predominantly silt-sized particles.

MAPPING UNIT - A group of soils that have selected common properties: they are used as a unit to separate them from other groups of soils.

MEAN ANNUAL INCREMENT - (MAI). The total yield (volume) of a forest stand divided by the age of the stand.

MILLIEQUIVALENTS (me) - One thousandth of the weight of clay or organic colloid that has a combining power equal to 1 gram-atomic weight of hydrogen. The atomic or formula weight divided by valence/1000.

MORPHOLOGY (soil) - The makeup of the soil, including texture, structure, consistence, colour and other physical, mineralogical and biological properites of the various horizons of the soil profile, and the kinds thickness and arrangement of the horizons in the profile.

MOTTLES - Spots or blotches of different colour or shades of colour interspersed with the dominant colour. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottling in soils indicates poor aeration and lack of good drainage.

ORDER (soil) - The highest category in the Canadian soil classification system. All soils within an order have one or more basic characteristics in common.

OUTWASH - Sediments "washed out" by flowing water beyond the glacier and laid down in thin foreset beds as stratified drift. Particle size may range from boulders to silt.

PARENT MATERIAL - The unconsolidated and more or less chemically unweathered mineral or organic matter from which the solum of a soil is developed by pedogenic processes.

PEAT - Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, organic matter.

PEDOLOGY - Those aspects of soil science involving the origin, constitution, distribution, genesis, morphology, and classification of soils.

PERCOLATION, SOIL WATER - The downward movement of water through the soil.

PERMEABILITY - The ease with which water and air pass through a bulk mass of soil or a layer of soil.

pH, SOIL - The negative logarithm of the hydrogen-ion acitivity, indicating the intensity of acidity or alkalinity of a soil.

PLASTIC LIMIT - (1) The water content corresponding to an arbitrary limit between the plastic and the semisolid state of consistence. (2) Water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter.

PLASTICITY INDEX - The numerical difference between the liquid limit and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

PROFILE, SOIL - A vertical section of the soil through all its horizons and extending into the parent material.

REACTION, SOIL - The degree of acidity or alkalinity of a soil, usually expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: extremely acid, < 4.5; very strongly acid, 4.5-5.0; strongly acid 5.1-5.5; moderately acid, 5.6-6.0; slightly acid, 6.1-6.5; neutral 6.6-7.3; slightly alkaline, 7.4-7.8; moderately alkaline, 7.9-8.4; strongly alkaline, 8.5-9.1; and very strongly alkaline, > 9.1.

REGOLITH - The unconsolidated mantle of weathered rock and soil material on the earth's surface, overlying solid rock.

RELIEF - The difference in elevations or irregularities of the land surface when considered collectively.

SAND - A soil particle between 0.05 and 2.0 mm in diameter.

SEEPAGE - The escape of water downward through the soil. (2) The emergence of water from the soil along an extensive line of surface in contrast to a spring where the water emerges from a local spot.

SERIES, SOIL - The second category (II) in the Canadian Classification system. This is the basic unit of soil classification and consists of soils which are essentially alike in all major profile characteristics except the texture of the surface.

SILT - A soil separate consisting of particles between 0.05 and 0.002 mm in equivalent diameter.

SITE - (1) In ecology, an area described or defined by its biotic, climatic and soil conditions as related to its capacity to produce vegetation. (2) An area sufficiently uniform in biotic, climatic, and soil conditions to produce a particular vegetation.

SLICKENS - Fine-textured materials separated in placer mining and in ore-mill operations.

SOIL - The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effect), macro and micro-organisms, and topography, all acting over a period of time.

SOIL GENESIS - The mode of origin of the soil with special reference to the processes or soil-forming factors responsible for the development of the solum, or true soil, from the unconsolidated parent material.

SOIL STRUCTURE - The combination or arrangement of primary soil particles into secondary soil particles, units or peds, which are separated from adjoining aggregates by surfaces of weakness. Aggregates differ in grade (distinctness) of development. Grade is described as weak, moderate and strong. The aggregates vary in class (size) and are described as fine, medium, coarse, and very coarse. The size classes vary according to the type (shape) of structure. The kinds of structure mentioned in this report are:

Granular - having more or less rounded aggregates without smooth faces and edges.
Platy - having thin, plate-like aggregates with faces mostly horizontal.
Blocky - having blocklike aggregates with sharp, angular corners.
Subangular blocky - having blocklike aggregates with rounded and flattened faces and rounded corners.

Two forms of a structureless condition are recognized:

- single grain, are a loose incoherent mass of individual particles as in sands.
- massive, is a coherent mass showing no evidence of any distinct arrangement of soil particles.

By convention an aggregate is described in the order of grade, class, and type e.g. strong, medium, blocky or moderate, coarse, granular. In the parent material of soils the material with structural shapes may be designated pseudoblocky, pseudoplaty, etc. In stratified materials a bed is a unit layer distinctly separate from other layers and is one or more cm thick, but a lamina is a similar layer less than 1 cm thick.

SOIL SURVEY - The systematic examination, description, classification and mapping of soils in an area.

SOIL TEXTURE - The relative proportions of the various soil separates in a soil as described by the classes of soil texture.

For convenience, soil textures are grouped into five classes as follows:

Coarse-textured - sands, loamy sand, loamy fine sand.
Moderately coarse-textured - loamy very fine sand, sandy loam, fine sandy loam.
Medium textured - very fine sandy loam, loam, silt loam, silt, sandy clay loam (light).
Moderately fine-textured - clay loam, silty clay loam, sandy clay loam (heavy).
Fine-textured - sandy clay, silty clay, clay.

SOLUM - The upper horizons of a soil in which the parent material has been modified and within which most plant roots are confined. It consists usually of A and B horizons.

STONES - Rock fragments 10 inches in diameter if rounded, and 15 inches along the greater axis if flat.

STONINESS - The relative proportion of stones in or on the soil.

STRATIFIED MATERIALS - Unconsolidated gravel sand, silt, or clay or a combination of these materials arranged in strata or layers.

TALUS - Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

TERRACE - A level, usually narrow plain bordering a river, lake, or the sea. Rivers sometimes are bordered by a number of terraces at different levels.

TILTH - The physical condition of soil as related to its ease of tillage, suitability as a seedbed, and its impedance to seedling emergence and root penetration.

TOPOGRAPHY - The shape of the land surface such as hills, mountains or plains. The slopes may be smooth or irregular. The slope classes used in this report are defined as follows:

depressional or nearly level	0 to 0.5%
very gently sloping or gently undulating	0.5+ to 2%
gently sloping or undulating	2+ to 5%
moderately sloping or gently rolling	5+ to 9%
strongly sloping or moderately rolling	9+ to 15%
steeply sloping or strongly rolling	15+ to 30%
very steeply sloping or hilly	30+ to 60%
extremely sloping or very hilly	over 60%

TUFF - Volcanic ash usually more or less stratified and in various states of consolidation.

UNIFIED SOIL CLASSIFICATION SYSTEM (Engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

VARVE - A distinct band representing annual or rythmite deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light coloured layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark coloured layer of clay laid down in the fall and winter.

WATER HOLDING CAPACITY - The ability of a soil to hold water. The water-holding capacity of sandy soils is usually considered to be low, while that of clayey soils is high. It is often expressed in inches of water per foot depth of soil.

WATER TABLE - The upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

WEATHERING - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

WILTING POINT - The moisture content of a soil at which plants wilt and fail to recover their turgidity when placed in a dark humid atmosphere. The wilting point is commonly estimated by measuring the water content of a soil at 15 atmospheres tension.

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APPENDIX A

APPENDIX A

CLIMATE INFORMATION

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(Ref: Atmospheric Environment Service, 1975, Canadian Normals for Temperature and Precipitation. Vol. 151, 251, Environment Canada, Downsview, Ontario.)

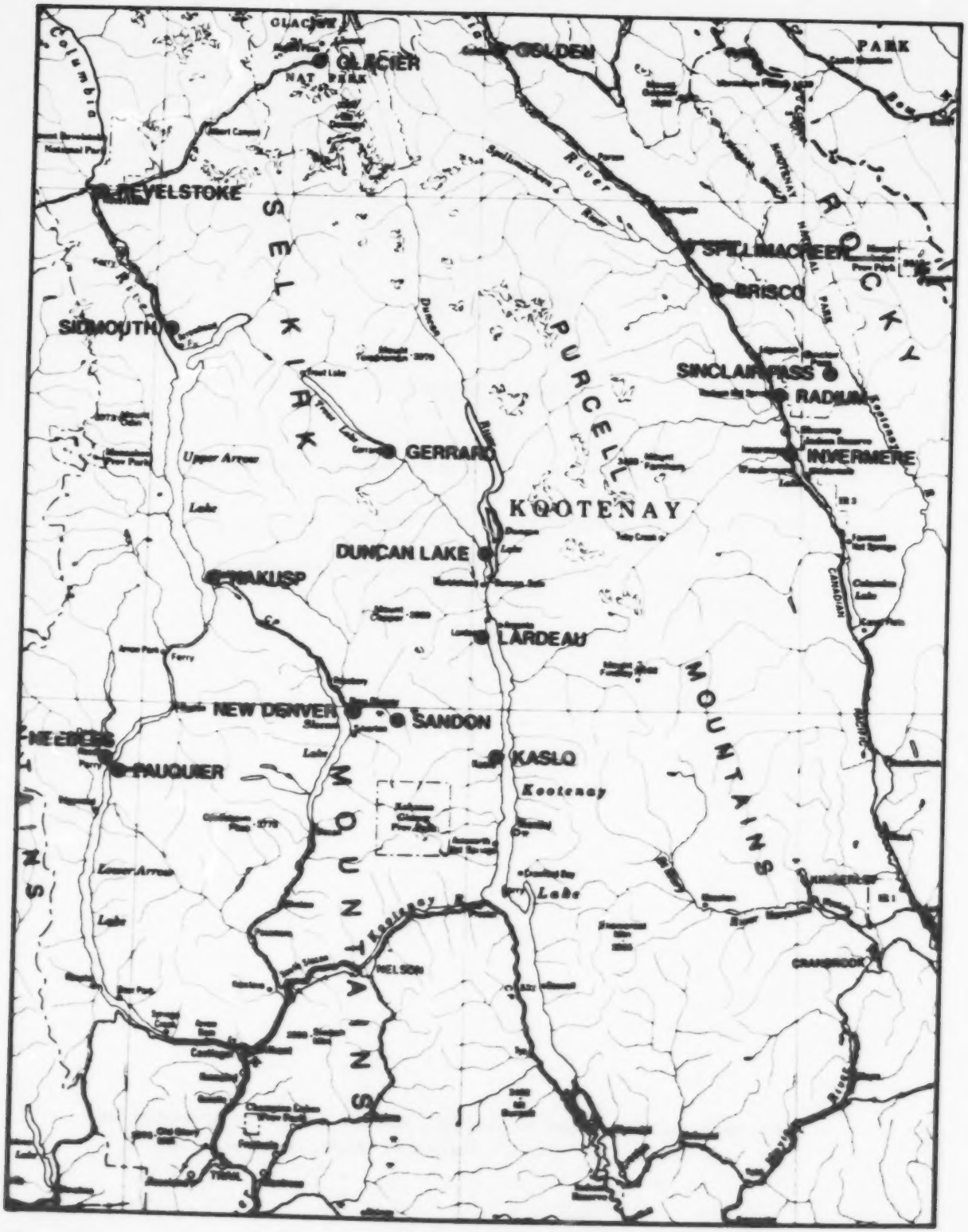

Figure 26: Climate stations mentioned in report

Table 10: Climatic information for some stations in and near the Lardeau map area

ELEVATION AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	SEASONAL MAY-SEPT	YEAR	TYPE OF NORMAL
BRISCO	LATITUDE 50° 49' N LONGITUDE 116° 16' W ELEVATION 2750 FT ASL														
Mean rainfall (Inches)	0.20	0.18	0.35	0.88	1.58	2.22	1.37	1.45	1.16	1.18	0.56	0.28		11.33	2
Mean snowfall	15.6	7.8	2.5	1.4	0.1	0.0	0.0	0.0	0.0	1.8	8.1	15.2		52.5	2
Mean total precipitation	1.76	0.96	0.60	1.02	1.59	2.22	1.37	1.45	1.16	1.28	1.32	1.81	7.79	16.54	2
GERRARD	LATITUDE 50° 30' N LONGITUDE 117° 10' W ELEVATION 2300 FT ASL														
Mean rainfall (Inches)	0.30	0.19	0.69	1.40	1.50	2.19	1.63	0.98	1.67	2.78	1.72	0.50		15.55	6
Mean snowfall	47.3	30.6	14.0	0.8	0.0	0.0	0.0	0.0	0.0	1.5	24.9	45.0		164.1	6
Mean total precipitation	5.03	3.25	2.09	1.48	1.50	2.19	1.63	0.98	1.67	2.93	4.21	5.00	7.97	31.96	6
GLACIER	LATITUDE 51° 14' N LONGITUDE 117° 29' W ELEVATION 4094 FT ASL														
Mean daily temperature (Deg. F)	13.5	18.4	26.5	36.0	45.4	52.7	57.9	55.8	48.3	37.4	24.3	18.4		36.2	1
Mean daily maximum temperature	18.5	25.2	34.6	46.0	57.2	65.0	71.8	68.8	58.6	44.0	28.7	23.1		45.0	1
Mean daily minimum temperature	8.4	11.5	18.3	26.9	33.6	40.4	43.9	42.7	37.9	30.7	19.9	13.7		27.3	1
Mean rainfall (Inches)	0.07	0.02	0.21	1.35	2.34	3.27	2.87	2.78	3.67	3.18	0.30	0.10		20.08	1
Mean snowfall	76.6	60.5	47.8	17.2	2.2	0.0	0.0	0.0	0.7	19.3	63.6	82.3		370.2	1
Mean total precipitation	7.73	6.07	4.99	3.07	2.56	3.27	2.87	2.78	3.74	5.03	6.66	8.33	15.22	57.10	1
GOLDEN	LATITUDE 51° 18' N LONGITUDE 116° 58' W ELEVATION 2583 FT ASL														
Mean daily temperature (Deg. F)	13.0	19.1	30.7	42.4	52.5	58.7	64.1	61.2	53.4	42.4	27.4	19.1		40.3	1
Mean daily maximum temperature	21.3	29.9	41.8	56.4	68.7	74.1	81.4	77.9	69.3	54.2	34.2	25.5		52.9	1
Mean daily minimum temperature	4.7	8.3	19.5	28.3	36.2	43.3	46.8	44.4	37.5	30.6	20.5	12.6		27.7	1
Mean rainfall (Inches)	0.18	0.22	0.34	0.71	1.09	1.54	1.24	1.38	1.30	1.23	0.68	0.45		10.36	1
Mean snowfall	20.6	13.5	5.1	2.6	0.4	0.0	0.0	0.0	0.0	3.8	12.6	22.3		80.9	1
Mean total precipitation	2.24	1.57	0.85	0.97	1.13	1.54	1.24	1.38	1.30	1.61	1.94	2.68	6.59	18.45	1
INVERMERE	LATITUDE 50° 30' N LONGITUDE 116° 02' W ELEVATION 2840 FT ASL														
Mean rainfall (Inches)	0.11	0.08	0.21	0.50	1.31	1.91	1.12	1.29	1.11	0.82	0.25	0.11		8.78	1
Mean snowfall	6.4	5.4	2.5	0.4	0.1	0.0	0.0	0.0	0.0	1.5	5.6	7.9		29.8	1
Mean total precipitation	0.75	0.58	0.46	0.54	1.32	1.91	1.12	1.29	1.11	0.97	0.81	0.99	6.75	11.76	1
KASLO	LATITUDE 49° 55' N LONGITUDE 116° 55' W ELEVATION 1930 FT ASL														
Mean daily temperature (Deg. F)	25.3	30.1	34.8	43.6	52.3	58.7	64.6	63.3	55.0	44.5	34.6	28.9		44.6	1
Mean daily maximum temperature	30.8	36.9	43.1	54.1	64.3	70.1	78.2	76.2	66.2	52.5	40.2	33.8		53.9	1
Mean daily minimum temperature	19.7	23.3	26.4	33.0	40.3	47.1	50.9	50.2	43.8	36.4	29.0	24.1		35.4	1
No. of days with frost	29	26	26	15	2	0	0	0	1	8	20	27		154	1
Mean total precipitation (Inches)	4.13	3.04	2.16	1.61	2.00	2.34	1.57	1.77	1.83	2.83	3.43	4.20	9.51	30.98	1
KOOTENAY NATIONAL PARK RADIUM	LATITUDE 50° 39' N LONGITUDE 116° 01' W ELEVATION 3570 FT ASL														
Mean daily temperature (Deg. F)	13.2	22.1	29.8	40.6	50.0	56.1	62.2	60.1	51.8	40.0	26.2	17.5		39.1	8
Mean daily maximum temperature	19.7	31.1	40.1	52.2	63.5	69.7	78.3	75.6	65.3	49.9	32.2	23.2		50.1	8
Mean daily minimum temperature	6.6	13.0	19.5	29.0	36.5	42.5	46.1	44.6	38.1	30.0	20.2	11.6		28.1	8
No. of days with frost	31	28	30	24	8	1	0	1	6	19	29	31		208	5
No. of days with measurable rain	0	0	1	6	10	11	9	10	9	6	1	0		63	5
No. of days with measurable snow	10	6	4	2	0	0	0	0	0	1	5	9		37	5
No. of days with measurable precipitation	10	6	5	7	10	11	9	10	9	7	6	9		99	5
Mean rainfall (Inches)	0.0	0.05	0.15	1.10	1.96	3.03	2.37	1.93	1.96	1.00	0.17	0.0		13.72	8
Mean snowfall	15.0	10.3	7.0	4.5	0.0	0.0	0.0	0.0	0.0	1.7	10.4	14.0		63.9	8
Mean total precipitation	1.50	1.08	0.85	1.55	1.96	3.03	2.37	1.93	1.96	1.27	1.22	1.40	11.25	28.12	8
LARDEAU	LATITUDE 50° 12' N LONGITUDE 116° 58' W ELEVATION 1805 FT ASL														
Mean daily temperature (Deg. F)	25.2	30.2	34.9	44.5	52.6	58.4	63.8	62.5	54.9	44.8	35.2	29.2		44.7	8
Mean daily maximum temperature	29.9	36.4	43.0	54.8	64.8	69.9	77.5	76.2	66.6	52.7	39.9	33.8		53.7	8
Mean daily minimum temperature	20.4	24.0	26.7	34.1	40.3	46.8	50.0	48.7	43.1	36.8	30.5	25.4		35.6	8
No. of days with frost	27	23	23	11	3	0	0	0	1	8	16	23		135	6
Mean rainfall (Inches)	0.88	1.51	1.18	1.26	1.75	1.95	1.52	1.65	1.74	2.32	1.84	1.39		18.02	8
Mean snowfall	25.8	17.5	3.6	1.0	0.1	0.0	0.0	0.0	0.0	0.7	8.0	21.2		77.9	8
Mean total precipitation	3.46	3.26	1.54	1.36	1.76	1.96	1.52	1.65	1.74	2.39	2.64	3.32	8.64	26.61	8

Table 10 Cont'd

ELEVATION AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	SEASONAL MAY-SEPT	YEAR	TYPE OF NORMAL
WAKUSP	LATITUDE 50° 14' N LONGITUDE 117° 48' W ELEVATION 1500 FT ASL														
Mean rainfall (Inches)	0.47	0.56	1.41	1.42	2.63	2.84	1.94	1.29	2.38	2.90	2.24	1.62		21.88	6
Mean snowfall	29.8	20.4	5.9	0.2	0.0	0.0	0.0	0.0	0.0	1.1	6.8	30.4		94.6	6
Mean total precipitation	3.65	2.58	2.00	1.44	2.63	2.84	1.94	1.29	2.38	3.01	2.92	4.66	11.08	31.34	6
NEEDLES WHATSHAN PH	LATITUDE 49° 55' N LONGITUDE 118° 04' W ELEVATION 1421 FT ASL														
Mean rainfall (Inches)	0.30	0.41	0.87	1.37	1.81	2.19	1.52	1.79	1.67	2.16	1.51	0.69		16.29	8
Mean snowfall	25.2	13.0	6.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	7.8	24.5		77.1	8
Mean total precipitation	2.82	1.71	1.47	1.40	1.81	2.19	1.52	1.79	1.67	2.19	2.29	3.14	8.98	24.00	8
NEW DENVER	LATITUDE 49° 59' N LONGITUDE 117° 23' W ELEVATION 1850 FT ASL														
Mean rainfall (Inches)	1.10	1.22	1.51	1.54	2.22	2.45	1.66	1.89	2.02	3.02	2.30	1.34		22.27	2
Mean snowfall	27.7	15.3	5.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	5.8	24.8		79.0	2
Mean total precipitation	3.88	2.75	2.02	1.57	2.22	2.45	1.66	1.89	2.02	3.03	2.89	3.84	10.24	30.22	2
REVELSTOKE	LATITUDE 51° 00' N LONGITUDE 118° 12' W ELEVATION 1497 FT ASL														
Mean daily temperature (Deg. F)	21.3	28.7	35.4	45.0	55.0	61.5	67.0	64.7	56.7	44.6	33.4	25.6		44.9	2
Mean daily maximum temperature	27.0	35.7	44.5	56.7	69.1	74.6	82.0	78.4	68.8	51.5	38.0	30.0		54.7	2
Mean daily minimum temperature	15.7	21.6	26.2	33.3	40.9	48.3	51.9	50.9	44.5	37.6	28.8	21.1		35.1	2
No. of days with frost	29	25	24	13	3	0	9	0	1	7	20	28		150	2
Mean rainfall (Inches)	1.12	1.30	1.89	2.11	2.02	2.92	2.25	2.52	2.99	4.04	2.83	1.69		27.68	2
Mean snowfall	51.8	31.2	9.7	1.2	0.0	0.0	0.0	0.0	0.0	1.3	20.0	46.9		162.1	2
Mean total precipitation	5.96	4.27	2.84	2.23	2.02	2.92	2.25	2.52	2.99	4.17	4.78	6.21	12.7	43.16	2
SANDON	LATITUDE 49° 58' N LONGITUDE 117° 13' W ELEVATION 3550 FT ASL														
Mean rainfall (Inches)	0.63	0.20	0.64	1.79	2.89	3.61	2.27	2.84	3.09	2.55	1.27	0.30		23.16	8
Mean snowfall	41.4	31.2	24.8	7.6	0.7	0.0	0.0	0.0	0.0	5.9	27.9	44.3		183.8	3
Mean total precipitation	4.77	3.32	3.12	2.55	2.96	3.61	2.27	2.84	3.09	4.14	4.06	4.81	14.77	41.54	8
SIDMOUTH	LATITUDE 50° 47' N LONGITUDE 118° 01' W ELEVATION 1410 FT ASL														
Mean daily temperature (Deg. F)	18.8	26.0	32.3	42.7	53.3	58.9	63.5	61.0	53.6	42.3	32.4	24.1		42.4	8
Mean daily maximum temperature	25.5	34.6	43.0	56.6	68.8	73.4	80.6	77.4	68.3	51.3	38.3	30.0		53.9	8
Mean daily minimum temperature	12.0	17.4	21.6	29.7	37.8	44.3	46.4	44.6	38.9	33.3	26.5	18.2		30.9	8
No. of days with frost	31	28	31	23	7	1	0	0	6	16	24	30		197	5
Mean rainfall (Inches)	0.66	1.04	1.95	1.77	1.67	2.33	2.00	2.23	2.90	3.71	2.92	1.25		23.82	8
Mean snowfall	58.0	31.0	12.8	2.0	0.0	0.0	0.0	0.0	0.0	1.2	18.5	59.1		182.6	8
Mean total precipitation	6.46	4.24	3.23	1.97	1.67	2.33	2.00	2.23	2.90	3.83	4.77	7.16	10.52	42.18	8
SINCLAIR PASS	LATITUDE 50° 40' N LONGITUDE 115° 58' W ELEVATION 3840 FT ASL														
Mean daily temperature (Deg. F)	11.9	19.9	25.2	35.3	44.4	50.2	56.2	54.9	46.5	37.0	22.6	15.4		35.0	8
Mean daily maximum temperature	19.0	28.8	35.2	46.1	56.9	62.2	70.8	68.9	58.3	45.9	30.9	22.0		45.4	8
Mean daily minimum temperature	4.8	11.0	15.2	24.5	31.9	38.1	41.5	40.9	34.6	28.1	14.3	8.8		24.5	8
No. of days with frost	31	28	31	28	18	5	1	2	12	26	30	31		243	5
Mean rainfall (Inches)	0.02	0.01	0.10	0.59	2.42	3.28	2.02	2.17	1.55	1.07	0.29	0.10		13.62	8
Mean snowfall	20.3	14.5	13.1	8.4	1.8	0.2	0.0	0.0	0.3	5.0	14.5	25.2		103.3	8
Mean total precipitation	2.04	1.46	1.41	1.43	2.60	3.30	2.02	2.17	1.58	1.57	1.74	2.62	11.67	23.94	8
SPILLIMACHEEN	LATITUDE 50° 55' N LONGITUDE 116° 24' W ELEVATION 2615 FT ASL														
Mean daily temperature (Deg. F)	12.7	21.2	30.4	41.9	51.7	57.5	62.9	60.5	52.2	41.0	27.2	17.7		39.7	8
Mean daily maximum temperature	19.7	30.5	41.2	54.1	65.5	70.6	78.1	75.0	65.8	50.8	33.1	23.4		50.7	8
Mean daily minimum temperature	5.6	11.9	19.5	29.6	37.8	44.4	47.7	46.0	38.6	31.1	21.3	11.9		28.8	8
No. of days with frost	30	28	20	21	5	0	0	0	4	17	27	30		190	5
Mean rainfall (Inches)	0.21	0.37	0.31	0.88	1.38	2.06	1.44	1.36	1.19	1.01	0.71	0.42		11.34	8
Mean snowfall	15.2	7.4	2.2	1.0	0.1	0.0	0.0	0.0	0.0	0.5	7.0	14.2		47.6	8
Mean total precipitation	1.73	1.11	0.53	0.98	1.39	2.06	1.44	1.36	1.19	1.06	1.41	1.84	7.44	16.10	8

Table 11: Frost-free period and frost data

STATION	LAT.	LONG.	ELEVATION	AVERAGES BASED ON 1941-70 PERIOD OF RECORD				EXTREMES BASED ON FULL PERIOD OF RECORD									
									LAST FROST (SPRING)		FIRST FROST (FALL)		LONGEST		SHORTEST		
	deg. min	deg. min		YEARS	FROST-FREE PERIOD (DAYS)	LAST FROST (SPRING)	FIRST FROST (FALL)	YEARS	EARLIEST	LATEST	EARLIEST	LATEST	LAST FROST (SPRING)	FIRST FROST (FALL)	NO. OF DAYS	LAST FROST (SPRING)	FIRST FROST (FALL)	NO. OF DAYS
Fauquier	49 52	118 04	1550	30	150	May 11	Oct 9	56	Apr 21	June 10	Sept 3	Nov 12	May 10	Nov 12	185	May 28	Sept 3	97
Glacier	51 14	117 29	4094	14	85	June 12	Sept 6	54	May 13	July 13	July 27	Oct 6	May 14	Sept 19	127	July 6	Aug 19	43
Golden	51 18	116 58	2583	30	101	May 31	Sept 10	68	May 6	July 13	July 17	Oct 8	May 20	Oct 8	140	May 31	July 17	46
Kaslo	49 55	116 55	1930	30	145	May 9	Oct 2	63	Mar 28	June 1	Sept 8	Nov 7	Mar 28	Nov 6	222	May 18	Sept 16	120
Lardeau	50 12	116 58	1805	10	134	May 15	Sept 27	10	May 3	May 26	Sept 12	Oct 19	May 13	Oct 19	158	May 26	Sept 12	108
Revelstoke	51 00	118 12	1497	29	140	May 14	Oct 2	69	Apr 16	July 8	Aug 11	Nov 7	Apr 21	Oct 19	180	July 8	Aug 11	33
Sidmouth	50 47	118 01	1410	13	88	June 9	Sept 6	13	May 19	July 3	Aug 6	Sept 29	May 24	Sept 17	115	June 11	Aug 6	55
Sinclair Pass	50 40	115 58	3840	15	53	June 24	Aug 17	20	May 13	July 13	July 20	Sept 21	May 13	Sept 21	130	July 3	July 20	16
Spillimacheen	50 55	116 24	2615	13	119	May 20	Sept 17	13	Apr 26	June 22	Sept 3	Oct 7	May 17	Oct 7	142	June 22	Sept 6	75

TABLE 12

PROBABLE LAST SPRING AND FIRST FALL DATES OF THE OCCURRENCE OF MINIMUM TEMPERATURES

26, 28, 30, 32, 34 AND 36 (°F) FOR THE BRITISH COLUMBIA INTERIOR

TABLES FOR WEST KOOTENAY REGION

DUNCAN LAKE
FAUQUIER
GLACIER
GOLDEN
KASLO
LARDEAU
REVELSTOKE
SPILLIMACHEEN

(BRITISH COLUMBIA LAND INVENTORY, 1972)

Table 12 Cont'd

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

DUNCAN LAKE (4 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE*	3.6	3.6	1.2	2.3	3.5	7.0	5.2	8.8	9.6	7.8	11.5	13.5
Mean	50%	Apr 27	May 6	May 16	May 20	May 28	Jun 1	Sep 17	Sep 23	Sep 25	Oct 6	Oct 17	Oct 26
	40%	Apr 29	May 8	May 17	May 21	May 30	Jun 5	Sep 14	Sep 19	Sep 20	Oct 2	Oct 11	Oct 19
	30%	May 1	May 10	May 17	May 22	May 31	Jun 8	Sep 12	Sep 14	Sep 15	Sep 25	Oct 6	Oct 13
	20%	May 3	May 12	May 18	May 24	June 4	Jun 13	Sep 8	Sep 8	Sep 8	Sep 23	Sep 27	Oct 3
	10%	May 6	May 15	May 19	May 26	June 6	Jun 19	Sep 3	Sep 1	Aug 31	Sep 16	Sep 18	Sep 21

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	182	164	143	128	118	108
60%	173	156	143	122	112	101
70%	165	149	134	116	106	96
80%	153	138	128	107	97	87
87%	145	132	124	102	92	81
90%	138	126	120	97	87	76

For 36° Shortest Period 1965 77 Days
34° Shortest Period 1965 92 Days
32° Shortest Period 1965 111 Days
30° Shortest Period 1965 121 Days
28° Shortest Period 1965 131 Days
26° Shortest Period 1965 132 Days

For 36° Longest Period 1966 130 Days
34° Longest Period 1967 142 Days
32° Longest Period 1967 142 Days
30° Longest Period 1967 164 Days
28° Longest Period 1964 179 Days
26° Longest Period 1964 206 Days

Elevation: 1800'

Note: These tables should be used with caution as the series is too short to compute reliable statistics.

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

FAUQUIER (35 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE	3.0	3.6	3.2	2.7	3.0	2.2	3.6	2.7	3.0	2.8	2.6	2.8
Mean	50%	Apr 4	Apr 19	May 4	May 11	May 18	May 24	Sep 16	Sep 28	Oct 11	Oct 15	Oct 27	Nov 10
	40%	Apr 7	Apr 23	May 7	May 14	May 21	May 27	Sep 11	Sep 24	Oct 7	Oct 11	Oct 23	Nov 6
	30%	Apr 11	Apr 26	May 11	May 17	May 24	May 30	Sep 5	Sep 20	Oct 2	Oct 7	Oct 19	Nov 2
	20%	Apr 17	May 1	May 15	May 21	May 28	Jun 4	Aug 29	Sep 15	Sep 26	Oct 1	Oct 14	Oct 27
	10%	Apr 21	May 7	May 21	May 25	Jun 3	Jun 9	Aug 20	Sep 8	Sep 19	Sep 24	Oct 7	Oct 20

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	220	191	164	153	133	115
60%	213	183	157	146	126	107
70%	205	176	149	138	119	98
80%	193	166	139	128	110	86
87%	187	159	132	122	103	78
90%	182	153	126	117	97	72

For 36° Shortest Period 1934 27 Days
34° Shortest Period 1934 57 Days
32° Shortest Period 1933 107 Days
30° Shortest Period 1933 107 Days
28° Shortest Period 1933 148 Days
26° Shortest Period 1933 175 Days

For 36° Longest Period 1944 148 Days
34° Longest Period 1944 165 Days
32° Longest Period 1944 174 Days
30° Longest Period 1953 222 Days
28° Longest Period 1962 237 Days
26° Longest Period 1939 262 Days

Elevation: 1913-17 - 1460', 1921-64 - 1600', 1964 - 1400'

Note: Use these data with caution, as the location has changed several times.

*SE- Standard error of estimate

Table 12 Cont'd

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

GLACIER (15 YEARS)

SPRING — Last Occurrence (°F)

		<26	<28	<30	<32	<34	<36
	SE	3.9	2.6	3.8	4.0	3.1	2.7
Mean	50%	May 1	May 13	May 28	Jun 10	Jun 20	Jun 29
	40%	May 5	May 15	Jun 1	Jun 14	Jun 23	Jul 2
	30%	May 8	May 18	Jun 4	Jun 18	Jun 26	Jul 4
	20%	May 14	May 21	Jun 9	Jun 23	Jun 30	Jul 8
	10%	May 20	May 25	Jun 15	Jun 30	Jul 5	Jul 12

FALL — First Occurrence (°F)

		<36	<34	<32	<30	<28	<26
	SE	5.2	5.3	4.8	3.3	4.3	4.0
Mean	50%	Aug 8	Aug 22	Sep 8	Sep 21	Oct 2	Oct 11
	40%	Aug 3	Aug 17	Sep 3	Sep 18	Sep 23	Oct 7
	30%	Jul 29	Aug 12	Aug 30	Sep 15	Sep 20	Oct 3
	20%	Jul 22	Aug 4	Aug 23	Sep 10	Sep 14	Sep 23
	10%	Jul 13	Jul 27	Aug 16	Sep 5	Sep 7	Sep 21

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	165	142	116	90	63	40
60%	155	136	109	81	55	32
70%	148	125	103	73	47	25
80%	137	116	93	61	35	14
87%	130	110	87	54	29	7
90%	124	105	82	47	22	1

For 36° Shortest Period 1934 7 Days
34° Shortest Period 1934 11 Days
32° Shortest Period 1944 44 Days
30° Shortest Period 1943 60 Days
28° Shortest Period 1933 116 Days
26° Shortest Period 1933 116 Days

For 36° Longest Period 1940 92 Days
34° Longest Period 1940 105 Days
32° Longest Period 1941 115 Days
30° Longest Period 1944 157 Days
28° Longest Period 1944 189 Days
26° Longest Period 1940 200 Days

Elevation: 4094'

Note: These tables should be used with caution as the series is too short to compute reliable statistics.

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

GOLDEN (46 YEARS)

SPRING — Last Occurrence (°F)

		<26	<28	<30	<32	<34	<36
	SE	1.8	2.2	2.6	2.5	2.4	2.1
Mean	50%	May 9	May 18	May 29	Jun 5	Jun 8	Jun 15
	40%	May 12	May 21	Jun 2	Jun 9	Jun 12	Jun 19
	30%	May 15	May 25	Jun 6	Jun 13	Jun 16	Jun 23
	20%	May 19	May 30	Jun 13	Jun 19	Jun 22	Jun 27
	10%	May 24	Jun 5	Jun 20	Jun 26	Jun 28	Jul 2

FALL — First Occurrence (°F)

		<36	<34	<32	<30	<28	<26
	SE	2.7	2.7	2.5	2.3	2.4	2.8
Mean	50%	Aug 21	Aug 31	Sep 11	Sep 16	Sep 23	Sep 26
	40%	Aug 17	Aug 27	Sep 7	Sep 13	Sep 20	Sep 22
	30%	Aug 13	Aug 22	Sep 3	Sep 9	Sep 16	Sep 17
	20%	Aug 6	Aug 16	Aug 28	Sep 3	Sep 10	Sep 10
	10%	Jul 29	Aug 8	Aug 21	Aug 28	Sep 3	Sep 2

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	140	128	110	98	84	67
60%	133	122	103	90	76	59
70%	115	114	95	82	67	51
80%	114	103	82	70	55	40
87%	108	97	76	64	35	34
90%	101	90	69	56	41	27

For 36° Shortest Period 1932 7 Days
34° Shortest Period 1933 16 Days
32° Shortest Period 1946 47 Days
30° Shortest Period 1946 47 Days
28° Shortest Period 1946 67 Days
26° Shortest Period 1933 116 Days

For 36° Longest Period 1961 112 Days
34° Longest Period 1963 128 Days
32° Longest Period 1963 141 Days
30° Longest Period 1930 143 Days
28° Longest Period 1948 153 Days
26° Longest Period 1940 185 Days

Elevation: 2580'

Table 12 Cont'd

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

KASLO (35 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE	2.8	2.4	2.0	2.1	1.9	2.2	1.8	1.9	2.2	2.8	2.5	2.4
Mean	50%	Apr 8	Apr 15	Apr 27	May 8	May 16	May 25	Sep 19	Sep 26	Oct 5	Oct 18	Oct 25	Nov 7
	40%	Apr 12	Apr 19	Apr 30	May 11	May 19	May 28	Sep 16	Sep 23	Oct 2	Oct 14	Oct 21	Nov 3
	30%	Apr 16	Apr 22	May 3	May 14	May 22	Jun 1	Sep 14	Sep 20	Sep 29	Oct 10	Oct 18	Oct 31
	20%	Apr 22	Apr 27	May 7	May 18	May 26	Jun 5	Sep 10	Sep 16	Sep 24	Oct 4	Oct 13	Oct 26
	10%	Apr 29	May 3	May 12	May 23	May 30	Jun 11	Sep 6	Sep 12	Sep 19	Sep 27	Oct 6	Oct 20

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	213	193	174	150	133	117
60%	205	185	167	144	127	111
70%	198	179	160	138	121	105
80%	187	169	150	129	113	97
87%	180	162	144	124	109	92
90%	174	156	138	119	105	87

For 36° Shortest Period 1943 83 Days — For 36° Longest Period 1938 151 Days

34° Shortest Period 1965 101 Days — 34° Longest Period 1947 164 Days

32° Shortest Period 1951 120 Days — 32° Longest Period 1937 205 Days

30° Shortest Period 1965 132 Days — 30° Longest Period 1937 207 Days

28° Shortest Period 1950 151 Days — 28° Longest Period 1934 231 Days

26° Shortest Period 1942 171 Days — 26° Longest Period 1934 251 Days

Elevation: 1930'

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

LARDEAU (6 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE	4.0	6.3	4.9	6.1	6.2	5.7	4.5	4.5	6.3	7.3	7.0	10.4
Mean	50%	Apr 12	Apr 23	Apr 29	May 10	May 11	May 22	Sep 16	Sep 19	Sep 27	Oct 3	Oct 15	Oct 29
	40%	Apr 15	Apr 27	May 2	May 14	May 15	May 25	Sep 13	Sep 16	Sep 23	Sep 28	Oct 10	Oct 22
	30%	Apr 17	May 1	May 5	May 17	May 19	May 29	Sep 10	Sep 13	Sep 19	Sep 23	Oct 6	Oct 15
	20%	Apr 20	May 6	May 9	May 23	May 24	Jun 3	Sep 6	Sep 9	Sep 13	Sep 16	Sep 29	Oct 5
	10%	Apr 25	May 13	May 12	May 29	May 30	Jun 9	Sep 1	Sep 6	Sep 6	Sep 8	Sep 21	Sep 24

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	200	175	157	140	131	117
60%	190	166	149	132	124	110
70%	181	158	141	125	117	104
80%	168	146	130	113	108	95
87%	160	138	124	106	104	89
90%	152	131	119	100	99	84

For 36° Shortest Period 1967 103 Days — For 36° Longest Period 1966 154 Days

34° Shortest Period 1964 109 Days — 34° Longest Period 1966 154 Days

32° Shortest Period 1964 109 Days — 32° Longest Period 1966 163 Days

30° Shortest Period 1962 126 Days — 30° Longest Period 1966 186 Days

28° Shortest Period 1965 161 Days — 28° Longest Period 1966 197 Days

26° Shortest Period 1965 161 Days — 26° Longest Period 1962 244 Days

Elevation: 1805'

Note: These tables should be used with caution as the series is too short to compute reliable statistics.

Table 12 Cont'd

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

REVELSTOKE (36 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE	2.8	2.0	2.2	2.1	2.1	2.3	3.6	2.8	3.0	2.9	3.1	3.2
Mean	50%	Apr 14	Apr 17	Apr 28	May 18	May 23	May 28	Sep 14	Sep 20	Sep 29	Oct 10	Oct 23	Nov 7
	40%	Apr 18	Apr 20	May 1	May 21	May 26	May 31	Sep 10	Sep 16	Sep 24	Oct 6	Oct 18	Nov 2
	30%	Apr 22	Apr 23	May 5	May 24	May 29	Jun 5	Sep 6	Sep 12	Sep 20	Oct 2	Oct 14	Oct 29
	20%	Apr 28	Apr 27	May 9	May 29	Jun 4	Jun 10	Sep 1	Sep 6	Sep 14	Sep 26	Oct 8	Oct 22
	10%	May 4	May 2	May 15	Jun 4	Jun 9	Jun 15	Aug 25	Aug 30	Sep 6	Sep 19	Sep 30	Oct 14

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	207	189	165	134	120	109
60%	198	181	158	126	113	102
70%	190	174	150	119	106	94
80%	177	164	140	108	95	84
87%	170	157	133	101	89	78
90%	163	151	127	95	83	72

For 36°	Shortest Period 1939	62 Days	For 36° Longest Period 1963 160 Days
34°	Shortest Period 1945	66 Days	34° Longest Period 1967 167 Days
32°	Shortest Period 1952	77 Days	32° Longest Period 1963 181 Days
30°	Shortest Period 1939	106 Days	30° Longest Period 1962 232 Days
28°	Shortest Period 1936	131 Days	28° Longest Period 1962 266 Days
26°	Shortest Period 1935	158 Days	26° Longest Period 1962 269 Days

Elevation 1497'

LAST SPRING AND FROST FALL DATE OF OCCURRENCE — MINIMUM TEMPERATURES OF 26,28,30,32,34,(°F)

FOR PROBABILITY 50% - 10%

SPILLIMACHEEN (10 YEARS)

		SPRING Last Occurrence (°F)						FALL First Occurrence (°F)					
		<26	<28	<30	<32	<34	<36	<36	<34	<32	<30	<28	<26
	SE	1.8	2.7	2.9	4.7	3.6	6.2	3.2	3.4	3.4	4.1	2.8	3.8
Mean	50%	Apr 27	May 12	May 15	May 20	May 27	Jun 7	Aug 31	Sep 10	Sep 17	Sep 22	Oct 5	Oct 14
	40%	Apr 28	May 14	May 17	May 24	May 30	Jun 12	Aug 28	Sep 7	Sep 14	Sep 19	Oct 3	Oct 11
	30%	Apr 30	May 16	May 20	May 27	Jun 2	Jun 17	Aug 26	Sep 5	Sep 12	Sep 16	Oct 1	Oct 8
	20%	May 2	May 19	May 23	Jun 2	Jun 6	Jun 24	Aug 22	Sep 1	Sep 8	Sep 12	Sep 28	Oct 4
	10%	May 4	May 20	May 27	Jun 8	Jun 11	Jul 2	Aug 18	Aug 27	Sep 3	Sep 6	Sep 24	Sep 30

MINIMUM PERIOD (DAYS) BETWEEN LAST SPRING AND FIRST FALL OCCURRENCE

FOR 50% - 90% PROBABILITY LEVELS

	<26	<28	<30	<32	<34	<36
50%	170	146	130	120	106	85
60%	166	142	125	113	100	77
70%	161	138	119	108	95	70
80%	155	132	112	98	87	59
87%	152	130	107	93	82	53
90%	149	127	102	87	77	47

For 36°	Shortest Period 1967	46 Days	For 36° Longest Period 1963 122 Days
34°	Shortest Period 1965	77 Days	34° Longest Period 1966 129 Days
32°	Shortest Period 1965	76 Days	32° Longest Period 1963 141 Days
30°	Shortest Period 1964	108 Days	30° Longest Period 1963 152 Days
28°	Shortest Period 1965	121 Days	28° Longest Period 1962 153 Days
26°	Shortest Period 1965	132 Days	26° Longest Period 1963 181 Days

Elevation: 2615'

Note: The values here are to be regarded as very approximate - the series is too short to compute reliable statistics.

APPENDIX B

APPENDIX B

THE CANADIAN SYSTEM OF SOIL CLASSIFICATION*

A classification is an orderly arrangement of objects or ideas placed into categories according to their relationship to each other. All objects are arranged in such a way that they succeed or accompany each other and thus provide us with groupings from a high level with broad generalizations to succeeding series of lower levels, each level in descending order being more specifically defined. Classes in all of the five categories: order, great group, subgroup, family and series, are based upon observable or measurable soil properties. Diagnostic properties at high categorical levels reflect soil genesis and hence the environmental factors that influence soil genesis. The 6 soil orders occurring in the Lardeau map area are defined below in brief, general terms and the great groups are listed.

Brunisolic order - Soils having genetic horizons but lacking the horizons diagnostic of other orders. They occur dominantly in subhumid to humid forested regions. Great groups are: Melanic Brunisol - has a mineral-organic surface horizon (Ah) and is not acid; Eutric Brunisol - lacks a well developed Ah and is not strongly acid; Sombric Brunisol - has an Ah and is strongly acid; Dystric Brunisol - lacks a well developed Ah and is strongly acid.

Chernozemic order - Soils of the grasslands; they have a well developed base-rich, mineral-organic surface horizon (Ah). The four great groups are based upon colour of the surface horizon which reflects soil climate: Brown, Dark Brown, Black and Dark Gray.

Gleysolic order - Soils having drab colours, prominent mottling or other features resulting from periodic or permanent high water table and reduction. They occur commonly in depressions and level areas that either receive runoff water or are groundwater discharge areas. There are three great groups: Humic Gleysol - well developed mineral-organic surface horizon (Ah); Gleysol - lacks a well developed Ah; Luvic Gleysol - has a B horizon (Btg) of significant clay accumulation.

Luvisolic order - Soils, usually in forested regions, in which leaching has resulted in significant translocation of clay from the A to the B horizon (Bt). The great groups are: Gray Brown Luvisol - mild soil climate and forest mull Ah; Gray Luvisol - cold to cool soil climate and may have no Ah.

Podzolic order - Acid soils developed under forest and heath; they have a B horizon enriched in Al and Fe weathering products, and humified organic matter. They usually underlie a light gray, weathered Ae horizon. Great groups are: Humic Podzol - B depleted of Fe; Ferro-Humic Podzol - B rich in organic matter combined with Al and Fe; Humo-Ferric Podzol - B contains less organic matter than Ferro-Humic Podzol.

Regosolic order - Development of genetic horizons is absent or very weakly expressed. Great groups are: Humic Regosol - has a dark, mineral-organic surface horizon (Ah); Regosol - either lacks or has a thin Ah.

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*The soils of the Lardeau map area were classified according to the soil taxonomic system of Canada. (Canada Department of Agriculture Publication 1455, 1970, revised 1973). The portion of the system applicable to the soils of the Lardeau map area is summarized here.

APPENDIX C

APPENDIX C

SOIL HORIZON NOMENCLATURE *

1. ORGANIC HORIZONS are found in organic soils, at the surface of mineral soils, or at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon by weight. Two groups of these layers are recognized:

   Of - The fibric layer, is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that is readily identifiable as to botanical origin.

   Om - The mesic layer, is intermediate in decomposition between the less decomposed fibric and the more decomposed humic materials. This material has intermediate values for fiber content, bulk density and water contents. The material is partly altered both physically and biochemically.

   Oh - The humic layer, is the most decomposed of all the organic soil materials. It has the least amount of plant fiber, the highest bulk density and the lowest saturated water-holding capacity. This material is relatively stable having undergone considerable change from the fibric state primarily because of oxidation and humification.

   L-F-H - These are organic layers developed mainly from leaves, twigs and wood materials under imperfectly to well drained conditions.

   L - An organic layer characterized by the accumulation of organic matter in which the original structures are easily discernible.

   F - An organic layer characterized by the accumulation of partly decomposed organic matter. The original structures are discernible with difficulty. Fungi mycelia are often present.

   H - An organic layer characterized by an accumulation of decomposed matter in which the original structures are indiscernible.

2. MASTER MINERAL HORIZONS AND LAYERS - Mineral horizons are those that contain less organic matter than that specified for organic horizons.

   A - This is a mineral horizon or horizons formed at or near the surface in the zone of removal of materials in solution or suspension or maximum accumulation of organic matter or both. Included are: 1) horizons in which organic matter has accumulated as a result of biologic activity (Ah); 2) horizons that have been eluviated of clay, iron, aluminum, or organic matter or all of these (Ae); 3) horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B); 4) horizons markedly disturbed by cultivation or pasture (Ap).

   B - This is a mineral horizon or horizons characterized by one or more of the following: 1) an enrichment in silicate clay, iron, aluminum or humus, along or in combination (Bt, Bf, Bfh, Bm and Bh); 2) an alteration by hydrolysis, reduction or oxidation to give a change in colour or structure from horizons above or below or both.

   C - This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting 1) the process of gleying; and 2) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca, Csa, Cg and C).

   R - This is underlying consolidated bedrock that is too hard to break with the hands or to dig when moist. The boundary between the R layer and any overlying unconsolidated materials is

*(Ref.: Canada Department of Agriculture Publication 1455, 1970, revised 1973)

called a lithic contact.

3. LOWER CASE SUFFIXES

b - A buried soil horizon.

c - A cemented (irreversible) pedogenic horizon.

ca - A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick and if it has a $CaCO_3$ equivalent of less than 15% it should have at least 5% more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15% $CaCO_3$ equivalent, it should have 1/3 more $CaCO_3$ equivalent than IC.

cc - Cemented (irreversible) pedogenic concretions.

e - A horizon characterized by removal of clay, iron, aluminum or organic matter alone or in combination. It is higher in colour value by one or more units when dry than an underlying B horizon.

f - A horizon enriched with hydrated iron. It usually has a chroma of three of more. It contains 0.6% or more pyrophosphate - extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate - extractable Al+Fe to clay (.002 mm) is more than 0.05 and organic C exceeds 0.5%. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bg horizons.

g - A horizon characterized by grey colours or prominent mottling or both indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less.

h - A horizon enriched with organic matter. When used with A alone, it refers to the accumulation of organic matter and the horizon contains less than 17% organic carbon. The Ah horizon has either one Munsell colour unit of value lower than the horizon immediately below, or has 0.5% more organic carbon than the IC, or both. When used with A and e it refers to an Ah horizon which has been degraded as evidence, under natural conditions, by streaks and splotches and often by platy structure.

j - Used as a modifier of e, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies.

k - Denotes the presence of carbonate as indicated by visible effervescence with dilute HCl.

m - A horizon slightly altered by hydrolysis, oxidation or solution, or all of them to give a change in colour or structure, or both. The suffix is used with B to denote A B horizon that is greater in chroma by one or more units than the parent material or that has granular, blocky or prismatic structure without evidence of strong gleying and contains pyrophosphate extractable Fe and Al of less than 0.4% for sands or less than 0.6% for textures finer than sand.

n - A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. When used with B, it must have a prismatic or columnar structure, dark coatings on ped surfaces and hard to very hard consistence when dry.

p - A layer disturbed by man's activities, that is by cultivation or pasturing or both. To be used only with A or O.

s - A horizon with salts including gypsum which may be detected as crystals or veins, as

surface crusts of salt crystals, or by distressed crop growth, or by the presence of salt tolerant plants.

sa - A horizon with secondary enrichment of salts, more soluble than Ca and Mg carbonates, where the concentration of salt exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 mmhos/cm and must exceed that of the C horizon by at least one-third.

t - A horizon enriched with silicate clay. It is used with B along (Bt). B and g (Bt_g) and with others.

x - A horizon of a fragipan character.

z - A permanently frozen layer.

y - A horizon affected by cryoturbation as manifested by disrupted and broken horizons and by incorporation of materials from other horizons and mechanical sortings.

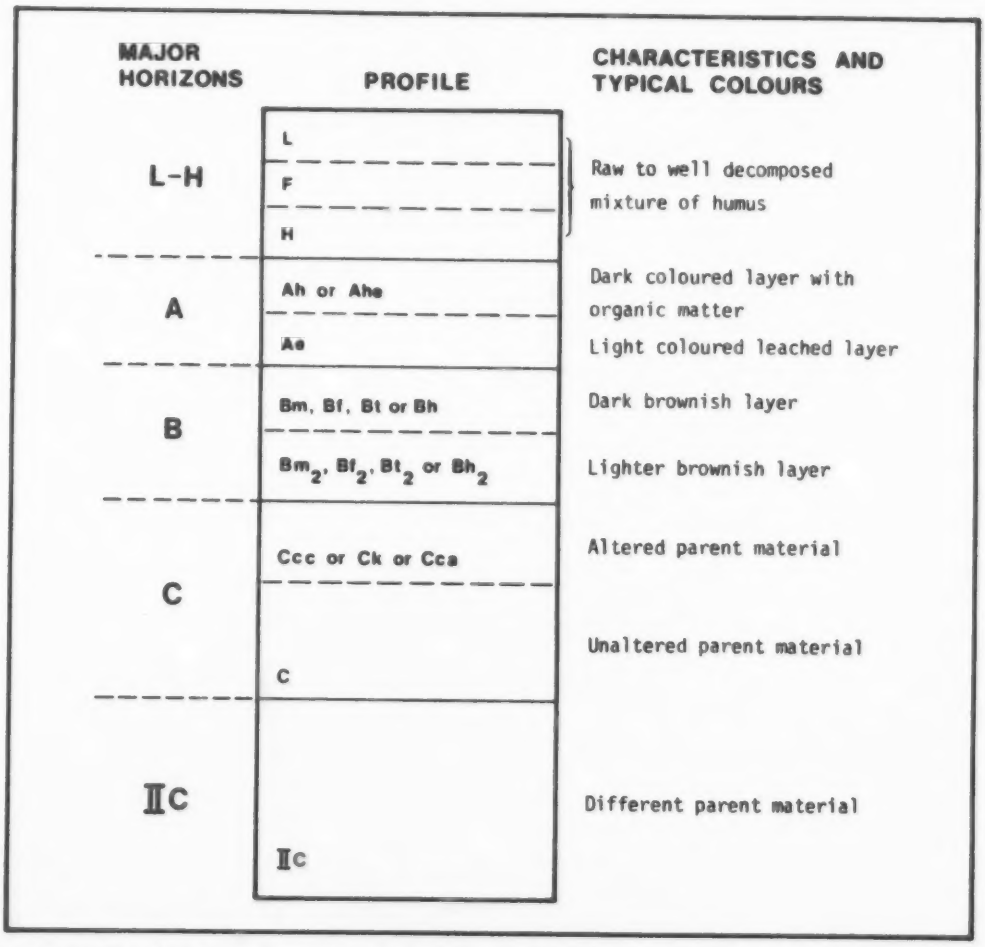

Figure 27: Usual sequence of soil horizons and symbol nomenclature for soil profiles

APPENDIX D

APPENDIX D

ENGINEERING PROPERTIES OF ROCKS

Some physical characteristics of different types of rocks are given in Table 13, mainly related to their suitability for use as road building material. However, these rocks may be affected differently by crushing; some may contain impurities of other rocks, and others may have a better physical shape for a certain specific use (Ref: USDC, Bureau of Public Roads, Vol. 2b, 1950).

Table 13: Engineering properties of rocks

TYPE OF ROCK	MECHANICAL STRENGTH	DURABILITY	CHEMICAL STABILITY	SURFACE CHARACTERISTICS	PRESENCE OF UNDESIRABLE IMPURITIES	CRUSHED SHAPE
Igneous:						
Granite, syenite, diorite	Good	Good	Good	Good	Possible	Good
Felsite	Good	Good	Questionable	Fair	Possible	Fair
Basalt, diabase, gabbro	Good	Good	Good	Good	Seldom	Fair
Peridotite	Good	Fair	Questionable	Good	Possible	Good
Sedimentary:						
Limestone, dolomite	Good	Fair	Good	Good	Possible	Good
Sandstone	Fair	Fair	Good	Good	Seldom	Good
Chert	Good	Poor	Poor	Fair	Likely	Poor
Conglomerate, breccia	Fair	Fair	Good	Good	Seldom	Fair
Shale	Poor	Poor		Good	Possible	Fair to good
Metamorphic:						
Gneiss, schist	Good	Good	Good	Good	Seldom	Good to poor
Quartzite	Good	Good	Good	Good	Seldom	Fair
Marble	Fair	Good	Good	Good	Possible	Good
Serpentinite	Fair	Fair	Good	Fair to poor	Possible	Fair
Amphibolite	Good	Good	Good	Good	Seldom	Fair
Slate	Good	Good	Good	Poor	Seldom	Poor

(Ref.: USDC, Bureau of Public Roads, Vol. 2b, 1950).

APPENDIX E

APPENDIX E

GUIDELINES FOR SOIL ENGINEERING AND RECREATION INTERPRETATIONS
AND A CLASSIFICATION OF SOIL AND SOIL-AGGREGATE MIXTURES
IN THE AASHO CLASSIFICATION SYSTEM

The following guidelines for soil engineering (Table 14) and soil recreation interpretations (Table 16) are extracted from: United States Department of Agriculture, Soil Conservation Service, Guide for Interpreting Engineering Uses of Soil, 1971 and Montgomery, P.H. and Edminster, F.C., Use of Soil Surveys in Planning for Recreation.

The guides are placed here as a reference only. More detailed information is found in the above mentioned publications.

Table 14: Guidelines for soil engineering interpretations

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Permeability class	Rapid, moderately rapid, and upper end of moderate	Lower end of moderate	Moderately slow and slow
Hydraulic conductivity rate (Uhland core method)	More than 1 in. hr.	1-0.6 in./hr.	Less than 0.6 in./hr.
Percolation rate (Auger hole method)	Faster than 45 min./in.	45-60 min./in.	Slower than 60 min./in.
Depth to water table	More than 72 in.	48-72 in.	Less than 48 in.
Flooding	None	Rare	Occasional or frequent
Slope	0-8%	8-15%	More than 15%
Depth to hard rock, bedrock, or other impervious materials	More than 72 in.	48-72 in.	Less than 48 in.
Stoniness class	0 and 1	2	3, 4, and 5
Rockiness class	0	1	2, 3, 4, and 5

A. INTERPRETATIONS FOR SEPTIC TANK ABSORPTION FIELDS

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Soil drainage class	Excessively drained, somewhat excessively drained, and well drained	Moderately well drained	Somewhat poorly drained, poorly drained, and very poorly drained
Seasonal water table	Below a depth of 60 in.	Between depths of 30 and 60in.	Above a depth of 30 in.
FTooding	None	Rare	Occasionally or frequent
Slope	0-8%	8-15%	More than 15%
Texture of soil to depth to be excavated	fsl, sl, l, sil, sicl, scl	si, cl, sc; all gravelly types	c, sic, s, ls; organic soil all very gravelly types
Depth to bedrock	More than 60 in.	40-60 in.	Less than 40 in.
Stoniness class	0 and 1	2	3, 4, and 5
Rockiness class	0	1	2, 3, 4, and 5

B. DEGREE AND LIMITATION OF SOIL PROPERTIES FOR SHALLOW EXCAVATIONS

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Soil drainage class	With basements: Excessively drained, somewhat excessively drained, well drained Without basements: Excessively drained, somewhat excessively drained, well drained, moderately well drained	With Basements: Moderately well drained Without basements: Somewhat poorly drained	With Basements: Somewhat poorly drained, poorly drained, very poorly drained Without basements: Poorly drained, very poorly drained
Seasonal water table (Seasonal means for 1 month or more)	With basements: Below a depth of 60 in. Without basements: Below a depth of 30 in.	With basements: Below a depth of 30 in. Without basements: Below a depth of 20 in.	With basements: Above a depth of 30 in. Without basements: Above a depth of 20 in.
Flooding	None	None	Rare, occasional or frequent
Slope	0-8%	8-15%	More than 15%
Shrink-swell potential	Low	Moderate	High
Unified soil group	GW, GP, SW, SP, GM, GC, SM, SC, CL with PI less than 15	ML, CL with PI 15 or more	CH, MH, OL, OH
Potential frost action	Low	Moderate	High
Stoniness class	0 and 1	2	3, 4, and 5
Rockiness class	0	1	2, 3, 4, and 5
Depth to bedrock	With basements: More than 60 in. Without basements: More than 40 in.	With basements: 40-60 in. Without basements: 20-40 in.	With basements: Less than 40 in. Without basements: Less than 20 in.

C. DEGREE OF LIMITATION OF SOIL PROPERTIES FOR DWELLINGS

Note: A distinction in above table is made when dwellings are built with or without basements. Bedrock limitations do not necessarily give severe limitation to the soil. The problem is more site specific depending upon slope of landform.

Table 14 Cont'd

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Depth of seasons high water table			Less than 72 in.
Soil drainage class	Excessively drained, somewhat excessively drained, well drained, and some moderately well drained	Somewhat poorly drained and some moderately well drained	Poorly drained and very poorly drained
Flooding	None	Rare	Occasional or frequent
Permeability	Less than 2.0 in./hr.	Less than 2.0 in./hr.	More than 2.0 in./hr.
Slope	0-15%	15-25%	More than 25%
Soil texture (dominant to a depth of 60 in.)	Sandy loam, loam, silt loam sandy clay loam	Silty clay loam, clay loam, sandy clay, loamy sand	Silty clay, clay, muck, peat, gravel, sand
Depth to bedrock - hard	More than 72 in.	More than 72 in.	Less than 72 in.
5 ft.	More than 60 in.	Less than 60 in.	Less than 60 in.
Stoniness class	0 and 1	2	3, 4, and 5
Rockiness class	0	0	1, 2, 3, 4, and 5

D. DEGREE OF LIMITATION OF SOIL PROPERTIES FOR SANITARY LANDFILL

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Moist consistence	Very friable, friable	Loose, firm	Very firm, extremely firm
Texture	Sandy loam, loam silt loam, sandy clay loam	Silty clay loam, clay loam, sandy clay, loamy sand	Silty clay, clay muck, peat, sand
Thickness of material (usually uppermost part of profile)	More than 40 in.	20-40 in.	Less than 20 in.
Coarse fragment: percent, by volume	Less than 15%	15-35%	More than 35%
Stoniness class	0 and 1	2	3, 4, and 5
Slope	Less than 8%	8-15%	More than 15%
Drainage class (wetness)	Note class determining if better than poorly drained		Poorly drained and very poorly drained

E. DEGREE OF LIMITATION OF SOIL PROPERTIES FOR AREA TYPE LANDFILL

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Soil drainage class	Excessively drained, somewhat excessively drained, well drained, and moderately well drained	Somewhat poorly drained	Poorly drained and very poorly drained
Flooding	None	Soils flooded less than once in 5 years	Soils flooded more than once in 5 years
Slope	0-8%	8-15%	More than 15%
Depth to bedrock	More than 40 in.	20-40 in.	Less than 20 in.
Subgrade			
a. AASHO group index	0-4	5-8	More than 8
b. Unified soil group	GW, GP, SW, SP, GM, GC, SM, SC	CL with PI less than 15	CL with PI 15 or more, CH, MH, OH, OL, Pt
Shrink-swell potential	Low	Moderate	High
Susceptibility to frost action	Low	Moderate	High
Stoniness class	0, 1, and 2	3	4 and 5
Rockiness class	0	1	2, 3, 4, and 5

F. DEGREE OF LIMITATION OF SOIL PROPERTIES FOR ROADS AND STREETS

SOIL PROPERTY AFFECTING USE	DEGREE OF SOIL LIMITATION		
	SLIGHT	MODERATE	SEVERE
Depth to water table (seasonal or year-round)	More than 60 in.	40-60 in.	Less than 40 in.
Permeability	Less than 0.6 in./hr	0.6-2.0 in./hr.	More than 2.0 in.
Depth to bedrock	More than 60 in.	40-60 in.	Less than 40 in.
Slope	Less than 2%	2-7%	More than 7%
Coarse fragments, less than 10 inches in diameter: percent, by volume	Less than 20%	20-50%	More than 50%
Percent of surface area covered by coarse fragments more than 10 inches in diameter	Less than 3%	3-15%	More than 15%
Organic matter	Less than 2%	2-15%	More than 15%
Flooding	None	None	Soils subject to flooding
Soil groups (Unifed) (rated for use mainly as floor of sewage)	GC, SC, CL, and CH	GM, ML, SM, and MH	GP, GW, SW, SP, OL, OH, and PT

G. DEGREE OF LIMITATION OF SOIL PROPERTIES FOR WATER RESERVOIR AREA OR SEWAGE LAGOONS

Table 15: Classification of soils and soil aggregate mixtures in the AASHO system

GENERAL CLASSIFICATION	GRANULAR MATERIALS (35% OR LESS PASSING NO. 200)							SILTY-CLAY MATERIALS (MORE THAN 35% PASSING NO. 200)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis % passing:											
No. 10	50 max.	-	-	-	-	-	-				
No. 40	30 max.	50 max.	51 min.	-	-	-	-				
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing:											
No. 40 - Liquid limit		-	-	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index		6 max.	N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Usual types of significant constituent materials	Stone fragments, gravel, and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to Good							Fair to good			

*Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

Table 16: Guidelines for soil - recreation interpretations

SOIL ITEMS AFFECTING USE	DEGREE OF SOIL LIMITATION		
	NONE TO SLIGHT	MODERATE	SEVERE
Wetness	Well to moderately well drained soils with no ponding and with water table below 3 feet	Moderately well drained soils with water table less than 3 feet and somewhat poorly drained soils with no ponding	Well drained, moderately well, and somewhat poorly drained with occasional ponding of short duration, poorly, and very poorly drained soils
Flooding	None	None	Subject to flooding during season of use
Permeability	Very rapid to moderate	Moderately slow	Slow and very slow
Slope	0-8%	8-15%	15%+
Surface soil texture	sl, fsl, vfsl, l, and ls with textural B horizon. Not subject to soil blowing	cl, scl, sicl, sil, ls, and sand other than loose sand	Organic, c, sic, c, loose sand, and soils subject to severe blowing
Coarse fragments <10"	Less than 15%	15-50%	50%+
Stoniness or rockiness	None	Classes 1 and 2	Classes 3, 4, and 5

A. Soil Limitations for Camp Areas (Intensive use)

SOIL ITEMS AFFECTING USE	DEGREE OF SOIL LIMITATION		
	NONE TO SLIGHT	MODERATE	SEVERE
Wetness	Well and moderately well drained soils with no ponding or seepage	Well and moderately well drained soils subject to occasional ponding or seepage of short duration, somewhat poorly drained soils	Somewhat poorly drained subject to ponding, poorly, and very poorly drained soils, too wet for use for periods of 1-5 weeks during season of use
Flooding	None during season of use	Subject to occasional flooding, no more than once in 3 years	Subject to more than occasional flooding during season of use
Permeability	Rapid, moderately rapid and moderate	Moderately slow	Slow and very slow
Slope	0-2%	2-8%	8%+
Surface soil texture	sl, fsl, vfsl, l and ls with textural B horizon	cl, scl, sicl, sil, ls, and sand	sc, sic, c, organic soils and sand and loamy sand subject to blowing
Depth to hard bedrock	3 feet+	2-3 feet+	Less than 2 feet
Stoniness	Class 0	Classes 1 and 2	Classes 3, 4, and 5
Rockiness	None	Class 1	Classes 2, 3, 4, and 5
Coarse fragments	Free of coarse fragments	Up to 15% coarse fragments	15%+

B. Soil Limitations for Play Areas (Intensive use)

SOIL ITEMS AFFECTING USE	DEGREE OF SOIL LIMITATION		
	NONE TO SLIGHT	MODERATE	SEVERE
Wetness	Well to moderately well drained soils not subject to ponding or seepage Over 4 feet to seasonal water table	Well and moderately well drained soils subject to occasional ponding or seepage, somewhat poorly drained not subject to ponding, seasonal water table 2-4 feet	Somewhat poorly drained soils subject to ponding, poorly and very poorly drained soils
Flooding	Not subject to flooding	Not subject to flooding	Subject to flooding
Slope	0-8%	8-15%	15%+
Rockiness	Class 0	Class 1	Classes 2, 3,4, and 5
Stoniness	Class 0 and 1	Class 2	Classes 3, 4, and 5
Depth to hard bedrock	5 feet+	3-5 feet	Less than 3 feet

C. Soil Limitations for Buildings in Recreational Areas

SOIL ITEMS AFFECTING USE	DEGREE OF SOIL LIMITATION		
	NONE TO SLIGHT	MODERATE	SEVERE
Soil drainage	Well and moderately well drained soils	Well and moderately well drained soils subject to seepage or ponding, and imperfectly drained soils	Rapidly drained poorly and very poorly drained soils
Depth to seasonal water table	Below 3 feet	1-3 feet	1 foot
Flooding	Not subject to flooding during season of use	May flood 1 or 2 times during season of use	Frequent flooding during season of use
Slope	0-15%	15-30%	30%
Surface texture	sl, fsl, vfsl, l	sil, sicl, scl, cl, sc, ls	sic, c, sand and soils subject to severe blowing all very gravelly, very cherty, very cobbly,
Surface stoniness or rockiness	Class 0, 1 and 2	Class 3	Classes 4 and 5

D. Soil Limitations for Paths and Trails

APPENDIX F

APPENDIX F

ACREAGE TABLES

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Table #17	Acreage of Agriculture Capability Classes of the Lardeau Map Area (by 1:50 000 NTS Mapsheets)	F2
Table #18	Acreage of Forestry Capability Classes of the Lardeau Map Area (by 1:50 000 NTS Mapsheets	F2
Table #19	Acreage of Soil Association (by 1:50 000 NTS Mapsheets) of the Lardeau Map Area	F3

Table 17 & 18: Capability class acreages

AGRICULTURE CAPABILITY CLASS	NTS MAP 82K/ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	% OF TOTAL AREA
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	1932	0	5040	768	996	1412	0	0	0	36	616	5012	0	0	0	15812	.42
3	0	1804	0	9904	112	1716	663	92	0	0	1412	2544	0	0	0	0	18247	.48
4	876	2020	1872	4432	8648	2328	872	588	8640	140	3136	976	0	0	976	7728	43236	1.15
5	18408	12440	5396	13584	12014	768	8312	19581	28268	1244	1848	17360	1420	9508	21720	26062	197933	5.27
6	31248	688	10830	13136	4972	884	2276	42916	58946	1814	14444	10764	1780	15540	20781	53650	284669	7.6
7	193608	215948	216780	108390	190964	239068	214022	180798	128816	234444	228446	210842	233656	220612	201607	105140	3195111	85.1

TABLE 17
ACREAGE OF AGRICULTURE CAPABILITY CLASSES

FORESTRY CAPABILITY CLASS	NTS MAP 82K/ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	% OF TOTAL AREA
1	0	13440	25976	43210	37360	27422	15264	0	0	7352	38982	40466	21008	840	0	520	271840	7.05
2	420	7728	17264	51396	21990	38054	15088	2500	648	8272	18970	34314	22124	80	0	908	239756	6.20
3	14792	35198	62676	23204	18934	14762	20108	22912	27056	6794	27210	18408	14040	3176	19234	19708	348212	9.03
4	21038	26600	9188	43124	51356	14628	13088	30742	55276	11688	19596	26352	12652	20460	29102	56229	441119	11.42
5	48374	30054	33936	19568	25880	25960	26420	61275	77918	24632	28248	20444	21528	10306	33552	55727	543822	14.09
6	29158	22740	13768	11612	21924	25044	13716	29492	32794	15408	18820	5560	26888	22822	19720	13638	323104	8.38
7	130746	94694	73940	34552	40228	86475	124200	97286	42608	162052	103733	99544	241868	189538	138446	32772	1692682	43.83

TABLE 18
ACREAGE OF FORESTRY CAPABILITY CLASSES

Table 19: Acreage of soil associations of the Lardeau map area

SOIL ASSOCIATION	SYMBOL	NTS MAP 82K/ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	APPROX % OF TOTAL
Avis	AS	-	1040	-	-	1164	-	360	-	-	136	1100	1308	-	170	1974	-	7252	0.5
	AS*	-	2590	408	320	-	2040	1768	-	-	232	480	-	5384	-	480	-	13702	
Badshot	BS	7754	-	-	-	-	-	-	6738	24180	-	-	-	-	-	1540	14748	54960	3.3
		5046	-	-	-	-	-	-	15220	22350	2120	-	-	-	-	-	30130	74866	
Beaton Creek	BA	-	3670	10590	4580	-	12372	18004	-	-	10052	8170	2816	6284	10860	300	-	87698	5.7
		-	7696	2520	12360	-	12022	9432	-	-	9964	26460	8172	8944	36830	280	-	134680	
Beatrice	BC	-	1330	4620	4204	6780	2652	-	-	-	-	520	-	-	-	-	-	20106	1.5
		-	3202	1420	12880	18680	1508	-	-	-	-	-	2348	1760	-	-	-	41798	
Bergman	BR	-	500	1510	432	3870	-	-	-	-	-	-	880	520	-	-	1292	9004	0.7
		-	1020	500	2372	5220	-	-	-	-	-	-	2960	3420	-	-	1720	17212	
Big Fish	BF	-	-	-	-	-	-	-	328	3270	-	-	-	-	-	4636	9116	17350	1.0
		-	-	-	-	-	-	-	440	4732	-	-	-	-	-	6712	11348	23232	
Blaylock	BY	-	3210	4030	1974	3600	2768	2580	-	-	1846	5310	1880	2156	6400	-	-	42944	2.7
		-	3670	12460	9125	-	9020	1658	-	-	2056	7900	5340	6096	3090	-	-	60415	
Blizzard	BZ	-	250	-	-	-	344	2002	-	-	468	-	-	-	-	-	-	3064	0.3
		-	-	-	-	-	-	7240	-	-	392	2400	-	-	-	-	-	10032	
Bluejoint	BT	-	3140	8366	2580	8060	6462	-	280	1550	944	2920	3420	320	-	-	-	38042	3.0
		560	4220	5950	17216	35998	2912	-	-	-	-	-	8572	-	-	-	-	75608	
Bohan Creek	BK	-	5470	1130	5312	5070	280	4552	-	-	-	200	2310	960	-	-	-	25284	1.8
		-	18750	2150	9654	8170	-	1172	-	-	-	-	4096	1200	-	-	-	45192	
Bonner	BO	-	6896	3340	5440	-	4440	5196	-	-	6436	5994	3220	6264	6840	-	-	54066	4.2
		388	5265	2570	7950	-	3765	1124	-	-	3584	21258	9460	40676	14630	100	-	110760	
Brennan	BB	17044		-	-	-	-	-	20108	80	-	-	-	-	-	2900	3680	43812	2.3
		19200	-	-	-	-	-	-	28316	-	-	-	-	-	-	-	344	47860	
Brouse	BE	-	4180	3714	-	-	-	904	-	-	-	360	-	-	-	-	-	9158	0.7
		-	-	12760	-	-	-	536	-	-	724	2720	-	-	-	-	-	16740	
Buhl Creek	BH	-	1340	240	2960	1600	-	-	-	-	-	-	4338	-	-	-	-	10478	0.5
		-	5980	-	386	-	-	-	-	-	-	-	1360	1920	-	-	-	9646	
Bunyon	BP	-	-	-	-	-	-	2836	504	860	6314	-	-	-	670	30922	-	42106	2.0
		1748	-	-	-	-	-	5412	7430	1224	5440	-	-	-	2160	12840	-	34505	
Burkitt	BM	-	-	1150	-	-	128	1368	-	-	-	2200	-	-	-	-	-	4746	0.3
		-	1000	370	-	-	290	1840	-	-	32	5450	-	-	-	-	-	8982	
Burn Creek	BU	-	820	2404	-	-	-	1688	-	-	-	-	-	-	-	-	-	4912	<.01
		-	-	400	-	-	-	360	-	-	-	-	-	-	-	-	-	760	
Calamity	CL	-	2740	460	2338	-	1018	1602	-	-	740	-	690	-	-	-	-	9588	0.7
		-	1400	3040	5582	-	1860	5694	-	-	-	-	2200	-	-	160	-	19936	
Carney	CY	-	1196	2016	5814	-	2978	3090	-	-	2612	-	-	-	3220	140	-	21066	2.0
		-	8196	10340	5394	-	10560	460	-	-	3700	4250	2738	1760	7000	-	-	54397	
Cataract	CL	-	1750	5982	1520	1640	5342	4194	-	-	3016	2620	1156	6352	1340	-	-	34912	4.1
		-	-	25900	3900	3000	15110	8088	-	-	6052	19410	5740	32184	4910	-	-	124294	
Cervil	CR	-	-	-	-	-	-	-	2634	1690	-	-	-	-	-	-	336	4660	0.2
		-	-	-	-	-	-	-	582	3000	-	-	-	-	-	1200	2234	7026	
Champion	CH	-	1020	-	-	-	-	-	-	-	452	-	-	-	-	200	-	1672	<.01
		-	870	-	580	-	-	-	-	-	-	-	-	-	-	-	-	1450	
Clifty	CF	-	200	-	300	-	-	-	-	-	-	-	-	-	-	-	-	500	<.01
		-	-	-	-	580	-	-	-	-	-	-	-	-	-	-	-	580	
Comaplix	CX	-	2765	1980	44	480	2152	-	-	-	-	-	3232	1324	-	-	-	11977	1.5
		-	6390	4150	-	21270	2014	-	-	-	-	360	8970	4644	-	-	-	47798	
Mount Cond	CS	-	1060	430	150	-	2522	-	-	-	-	3378	-	6914	5800	-	-	20254	1.6
		-	1980	6470	-	-	4660	760	-	-	-	6066	2780	8476	11500	-	-	42702	
Conrad	CN	-	-	-	-	-	-	220	-	290	408	-	-	-	-	3188	-	4108	0.3
		-	-	-	-	-	-	2636	528	-	1740	-	-	-	90	2948	-	7942	
Cooper	CP	-	3760	-	-	3520	-	-	-	-	-	-	304	-	-	-	-	7584	0.6
		-	5660	-	6090	3920	-	-	-	-	-	-	1918	-	-	-	-	17588	
Coppercrown	CC	196	1470	1012	1336	910	2482	-	-	-	84	-	2168	-	-	-	-	9658	1.4
		-	3320	11100	768	6598	16620	-	-	-	-	1180	3076	-	300	-	-	42962	
Coubrey	CB	4948	-	-	-	-	-	-	3021	410	278	-	-	-	-	4840	-	13897	1.4
		15136	-	-	-	-	-	-	17610	-	3420	-	-	-	-	3932	-	40098	
Couldron	CW	2764	-	-	-	-	-	-	5692	5570	32	-	-	-	-	-	1208	15266	1.9
		11164	-	-	-	-	-	-	12710	25000	750	-	-	-	-	-	10136	59760	

Table 19 Cont'd

SOIL ASSOCIATION	SYMBOL	NTS MAP 82K/ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	APPROX % OF TOTAL
Curtis	CT	232	120	1240	-	-	1384	-	-	-	-	136	180	2800	-	-	-	6092	0.7
		-	1060	4070	60	3410	9348	-	-	-	-	180	5200	-	-	-	-	23328	
Fairmont	FA	-	-	-	-	-	-	-	-	1560	-	-	-	-	-	-	3512	5092	0.2
		-	-	-	-	-	-	-	344	960	-	-	-	-	-	-	2412	3716	
Fruitvale	FT	-	360	200	2170	606	320	796	-	-	356	540	-	-	-	-	-	5598	0.3
		-	760	680	-	-	-	1040	-	-	232	-	-	2436	-	-	-	5148	
Gillis	GS	-	-	570	4472	6978	2440	40	-	-	-	-	110	-	-	-	-	12610	0.4
		-	-	-	3470	350	-	-	-	-	-	360	-	-	-	-	-	4180	
Kaslo	KO	-	190	1070	10272	6414	-	232	-	-	-	-	1834	400	-	-	-	20362	1.75
		-	1650	7940	13208	8720	-	-	-	-	-	-	15738	280	-	-	-	47536	
Keeney	KE	3043	-	-	-	-	-	-	4264	12896	60	-	-	-	-	1064	10954	32281	1.8
		7270	-	-	-	-	-	300	1970	6254	1236	-	-	-	-	4570	15438	37038	
Kimbasket	KB	160	-	-	-	-	-	-	-	28656	-	-	-	-	-	9964	27849	66631	3.2
		-	-	-	-	-	-	-	-	18626	-	-	-	-	-	7556	32888	59070	
Kingcome	KG	-	-	-	-	-	-	280	872	-	-	-	-	-	-	1000	-	1752	<.01
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	4208	-	4208	
Kuskanax	KX	-	-	500	1156	3130	1170	-	-	-	-	150	1108	-	-	-	-	7163	0.7
		-	-	1480	170	450	1210	-	-	-	-	2560	13120	480	-	-	-	19470	
Lawley	LY	-	-	-	-	68	-	-	-	-	-	-	-	-	-	-	-	68	<.01
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Linton	LI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mayook	MY	908	-	-	-	-	-	-	400	5192	-	-	-	-	-	-	3040	9530	0.2
		980	-	-	-	-	-	-	160	770	-	-	-	-	-	-	-	1910	
Nawitka	NA	112	-	-	-	-	-	380	352	9240	604	-	-	-	-	-	11000	21688	0.8
		2832	-	-	-	-	-	-	-	3420	336	-	-	-	-	2550	1520	10258	
Radium	RA	2236	-	-	-	-	-	-	2632	724	1324	-	-	-	400	-	120	7442	0.2
		-	-	-	-	-	-	-	700	-	-	-	-	-	-	-	816	1516	
Rossland	RL	984	1584	900	-	3770	3760	144	540	-	-	1134	2590	2036	1470	-	-	19272	2.0
		-	1980	3950	2000	520	2690	-	-	-	-	15730	7490	24690	4860	-	-	63470	
Sandner	SD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sandon	SA	-	-	170	-	-	-	-	-	-	-	-	-	-	-	-	-	170	<.01
		-	-	1220	-	-	-	-	-	-	-	-	-	2170	-	-	-	3390	
Sentinel	SL	-	1600	-	3884	1580	350	3320	-	-	-	-	-	-	-	-	-	10734	1.4
		-	1980	2110	11515	15090	2930	7176	-	-	2476	-	1449	-	-	-	-	44585	
Slocan	SN	-	260	-	8372	340	-	-	-	-	-	-	-	-	-	-	-	8972	0.6
		-	2680	260	4380	930	-	-	-	-	-	-	3138	3040	-	-	-	14378	
Spillimacheen	SP	2248	-	-	-	-	-	-	-	320	-	-	-	-	-	2120	7768	12956	1.0
		5590	-	-	-	-	-	-	8550	4324	-	-	-	-	-	3704	6080	28832	
St. Leon	ST	-	-	216	-	-	360	-	-	-	-	230	3858	-	-	-	-	4664	0.2
		-	1710	280	-	2509	-	-	-	-	-	-	256	-	-	-	-	4786	
Steenhoff	SF	-	60	2590	-	-	-	-	-	-	-	-	-	-	-	-	-	2650	0.3
		-	-	2650	-	-	3490	-	-	-	-	-	-	1280	-	-	-	7820	
Stobart	SB	-	-	-	2900	410	-	-	-	-	-	-	1476	1216	-	-	-	5102	0.4
		-	-	-	1636	2630	2140	1680	-	-	-	-	4788	-	-	-	-	12982	
Stubbs	SB	-	750	30	1575	-	2370	430	-	-	-	10260	8120	1520	-	-	-	25055	2.2
		-	-	4600	10650	-	9990	532	-	-	-	16110	9072	4492	5030	-	-	59980	
Swetlaw	SH	-	-	-	492	1150	-	-	-	-	-	-	-	-	-	-	-	1642	<.01
		-	-	330	1488	700	-	-	-	-	-	-	-	-	-	-	-	2514	
Wycliffe	WY	476	-	-	-	-	-	-	3048	13975	-	-	-	-	-	-	-	17499	0.8
		2150	-	-	-	-	-	-	7178	4410	-	-	-	-	-	-	-	13786	
Yahk Creek	YA	1484	-	-	-	-	-	160	1280	60	520	-	-	-	2850	1660	480	8898	0.8
		4950	-	-	-	-	-	924	4888	-	1864	-	-	-	4380	3230	-	20040	
Ymir	YM	-	700	4392	-	2034	8616	624	-	-	1488	2276	3200	-	4480	426	-	28252	1.6
		-	4464	3200	570	-	4816	1732	-	-	14836	1400	1000	-	730	1150	-	33920	
Glacier	G	1727	4300	1764	-	-	3677	20080	1649	-	15830	1600	-	440	4690	13154	-	69105	2.1
		-	-	-	-	-	-	-	-	-	-	1600	-	-	12580	-	-	14180	
Rock	RC	1432	2500	1600	-	1350	760	6732	240	2120	1080	1730	-	964	16480	1072	7400	94230	25.0
		110574	76050	33730	11040	29860	38434	63422	80510	33734	121550	49990	29184	46640	64780	101140	25026	924050	
Water	WA	268	-	-	-	-	-	-	-	514	-	-	-	-	-	320	884	1986	<.01
(Intermittent)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	712	712	
Moraine	M	3462	-	-	-	-	1790	-	-	-	-	-	-	-	880	-	-	6132	.01
		-	-	-	-	-	-	344	-	-	-	-	-	-	-	-	-	344	
Open Water		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0
		600	11992	4620	15000	23476	280	13100	1300	244	2492	8820	34080	1754	-	1000	-	118098	
Organics	O	-	-	-	-	-	-	-	120	-	-	-	436	-	-	-	-	556	<.01
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	936	936	

* The top line denotes acreage pure units of soil associations. The bottom line denotes acreage of complexes of soil associations.

APPENDIX G

APPENDIX G

CHEMICAL ANALYSES AND DETAILED SOIL PROFILE DESCRIPTIONS OF LARDEAU MAP AREA SOILS

Chemical and physical methods used in the analysis of soil profiles are discussed below.

pH measurements were made on 1:1 soil:water suspensions for mineral soils, and 1:5 soil:water suspension for organic soils. pH was also determined using a 1:5 soil:M/100 $CaCl_2$ solution according to Clark, 1965, modified by shaking one half hour instead of 5 days. A pH meter and a combination electrode were used for all pH measurements. Soil organic matter was determined by the wet combustion method as described by Grewelling and Peach (1960).

Total nitrogen was determined using the method described by Bremner.

Laverty's method (1961) modified by John (1963) was used to determine acid soluble and available phosphorus. Colour development was made following John's (1970) procedure.

Exchange capacity was determined using the method described by Peach (1957). The ammonium acetate extract was analyzed for exchangeable cations using a Techtron AA4 atomic absorption spectrophotometer.

Oxalate-extractable iron and aluminum and Pyrophosphate extractable iron and aluminum were determined following procedures described by McKeague (1971).

Sulphur analyses were made following the procedure of Bardsley and Lancaster (1960).

Manganese values were obtained by analyzing the extract from 1:5 soil:calcium chloride suspensions used for pH determination.

Boron analyses were made following the method of Grewelling and Peach.

The perchloric-nitric acid digestion for copper and zinc were made following the procedure of Lundblad (1949) and analyses were made using a Techtron AA4 atomic absorption spectrophotometer.

Mechanical analyses were made following the procedure outlined by Kilmer and Alexander (1949).

The following page is an example of a detailed profile description and laboratory data. Detailed descriptions of Lardeau map area soil profiles with accompanying laboratory data are not included in this report. They are stored in the B.C. Soil Data File and are available upon request. If needed please contact:

The Library
Resource Analysis Branch
Ministry of Environment
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SOIL: BONNER
PROJECT:

RESOURCE ANALYSIS BRANCH
MINISTRY OF ENVIRONMENT
VICTORIA, B.C.

NTS: 82K 4

SUMMARY DATE: JUNE 27, 1979

SOIL NAME: BONNER
DATE OF SURVEY: 73 SURVEYOR: BN
SAMPLING PURPOSE: RECONNAISSANCE SURVEY

UNIT TYPE: ASSOCIATION
KELOWNA, B.C.M.A. & R.A.B.

LOCATION

Latitude(°): 50 05 12
Longitude(W): 117 47 30
Precision (Sec): 30
Elevation (Ft): 6400

CLASSIFICATION

Orthic Humo-Ferric Podzol (1973)
Status: Modal Soil

SLOPE

%: 10.0
Type: Simple
Class: Strongly Sloping
Aspect (Deg): 225

PARENT MATERIAL AND LANDFORM

Genetic Material: Colluvial
Landform: Veneer
Rooting Depth: 18 in.

BEDROCK

Depth to Bedrock: 36 in.
Type: Metamorphic Fine Grained
Drainage: Well Drained
Permeability: Moderately Rapid
Infiltration: Medium

PROFILE DESCRIPTION

HORIZON	THICKNESS DEPTH(IN)	COLOUR 1	TEXTURE	STRUCTURE 1	CONSISTENCE	ROOTS 1
L-H	1- 0					
A HE	0- 2	10.0YR4.0/4.0 Crushed Dry	Sandy Loam Gravelly	Moderate Very Fine Subangular Blocky	Very Friable	Plentiful
B F1	2- 9	10.0YR4.0/3.0 Crushed Dry	Sandy Loam Gravelly	Moderate Very Fine Subangular Blocky	Very Friable	Few
B F2	9- 18	10.0YR5.0/4.0 Crushed Dry	Loamy Sand Gravelly	Moderate Very Fine Subangular Blocky	Very Friable	Few
BC	18- 26	2.5Y5.0/4.0 Crushed Dry	Loamy Sand Gravelly	Moderate Very Fine Subangular Blocky	Very Friable	
C	26- 36	2.5Y5.0/4.0 Crushed Dry	Loamy Sand Gravelly	Moderate Very Fine Subangular Blocky Pseudo	Very Friable	
R	36-					

PHYSICAL AND CHEMICAL DATA

HORIZON	DEPTH(IN)	PH 1 SAMPLE STATE	METHOD	VALUE	PH 2 SAMPLE STATE	METHOD	VALUE	ORGANIC CARBON %	NITROGEN %
L -H	1- 0	2	2	4.5	2	4	4.9	30.99	.92
A HE	0- 2	2	1	4.5	2	4	4.0	7.59	.28
B F1	2- 9	2	1	4.9	2	4	4.2	2.46	.14
B F2	9- 18	2	1	5.2	2	4	4.5	1.70	.10
BC	18- 26	2	1	5.0	2	4	4.6	.43	.03
C	26- 36	2	1	5.2	2	4	4.8		
R	36-								

HORIZON	DEPTH (IN)	EXCHANGEABLE CATIONS BUFF.(ME/100G) CA	MG	NA	K	C.E.C. DETERMINED	EXTRACTABLE FE(%) METHOD	RESULT	EXTRACTABLE AL(%) METHOD	RESULT	P1 PPM
L -H	1- 0										25.4
A HE	0- 2	3.03	.53	.20	.37	25.1					37.9
B F1	2- 9	.63	.12	.10	.11	15.4	3	.4	3	.5	50.1
B F2	9- 18	.98	.08	.23	.07	11.8	3	.3	3	.4	17.4
BC	18- 26	.24	.02	.10	.03	5.8					139.6
C	26- 36										88.8
R	36-										

HORIZON	DEPTH(IN)	S PPM
L -H	1- 0	
A HE	0- 2	12.9
B F1	2- 9	14.6
B F2	9- 18	1.5
BC	18- 26	1.1
C	26- 36	1.5
R	36-	

EXTRACTABLE FE, AL, MN(%) METHODS, CODE:

1...OXALATE EXTRACTABLE
2...DITHIONITE EXTRACTABLE
3...PYROPHOSPHATE EXTRACTABLE

PH METHODS, CODES:

1...H2O 1:1
2...H2O 1:5
3...H2O SATURATION
4...CACL2
5...KCL
6...NAF

Example of a detailed profile description and laboratory chemical analysis.

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